IMPERIAL METALS AND POWER LTD. (NPL)

- LODESTONE IRON AND STEEL PROJECT

92H/7W

- A. H. Lindley

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PREFACE

92H/10W

During July 30 to August 4, 1962 this writer made a preliminary investigation of the Coalmont, British Columbia Lodestone Iron and Tulameen Coal properties for Imperial Metals and Power Ltd. Discussions were also held with Imperial's staff; Norman D. Lea of N.D. Lea and Associates, consulting engineers; and Marubeni-Iida Company of Canada representatives -- a potential Japanese purchaser of iron and steel products.

The purpose of the investigation was to determine whether the preliminary technical and economic evidence of the proposed integrated iron and/or steel project merited additional development expenditure and, if so, what steps would be required to attract adequate capital to initiate production.

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September 4, 1962

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INTRODUCTION

Assuming low cost electric power and sufficient assured iron and coal reserves of a grade indicated by preliminary drilling and sampling at Lodestone Mountain and the Tulameen Coalfield, Imperial has the possibility of producing standard steel ingot at a lower direct cost than any existing integrated steel producer in North America. Fixed charges, however, will be large because of a new mine-mill plant and pipeline for coal and iron, a limestone quarry operation, a smelting-refining-rolling plant, and initially, thermal power facilities until low cost hydropower becomes available. (See sketch map, Fig. 1)

Preliminary evidence indicates that Imperial should strive for the sale of simple rolled steel products and billets to attain a maximum return per dollar invested. The original plant would probably have a small capacity because of existing markets, but once the capital had been repaid, Imperial could become more flexible in product mix and expand from a plow back of earnings as markets dictate, and at the same time have an excellent competitive position with those world iron and steel producers who already have their fixed charges written off.

This writer would suggest that Imperial take the following steps in sequence, assessing each item before proceeding with additional expenditures in determining the feasibility of this embryonic project:

1. Determine from potential consumers the prices they will pay for pig iron, steel billet, and/or rebar products of stated specification and quantity. This will provide Imperial with initial information as to what products must be sold to attain an adequate cash flow. For example, reinforcing and merchant bar outlets for British Columbia hydro power construction may prove a significant market.

2. The iron, coal, and limestone reserves should be drilled and/or trenched under recognized engineering supervision* so as to assure reserves of commercial grade for at least a 25 year operation at a 300,000 ton / year rate.

3. Once average grade of iron ore is known a bulk sample should be tested at Ottawa or Lakefield to determine the most efficient commercial concentrating flowsheet. The testwork will produce concentrate which can be used for smelting tests. This work should also be done by a recognized specialist in the field of iron ore concentration.

4. If the Udy Process is decided upon, about 6 tons or more of iron concentrate from the upgrading testwork should be smelted in a 100 Kw Udy furnace at Niagara Falls, New York. This testwork will provide data on power consumption; flux additives; and titanium, carbon, phosphorous, and sulphur control.

5. Strategic's 50 T/D magnetic concentrating plant could be adjusted to the developed flowsheet for Lodestone ore. Sufficient ore would be upgraded to operate the 1,000 Kw furnace for at least a ten day continuous run. Tulameen coal could also be shipped to Niagara Falls, Ontario for the runs.

6. Preparation of the integrated Imperial report, including fiscal projections, markets, technical backstopping, etc. for the purpose of raising the required capital.

*It is important that recognized experts tackle the individual specialized problems of this project for it to gain acceptance in fiscal and corporate circles should money be raised independently by Imperial.

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GENERAL GEOLOGY OF LODESTONE MOUNTAIN IRON DEPOSITS*

The Lodestone Mountain stock, centered near Coalmont, British Columbia, underlies mostly high country though it is cut deeply by valleys of the Tulameen River and Britton Creek in the north and Badger Creek in the south. In general terms the stock consists of a large body of pyroxenite enclosing one or possibly two bodies of peridotite-dunite.. The bulk of the iron containing magnetite is in pyroxenite. The magnetite occurs in two ways**, as individual grains disseminated through the rock and as lenses or vein-like bodies. Although the Lodestone stock extends in radius for over seven miles from Lodestone Peak and represents extensive potential ground for further exploration, Imperial has concentrated its initial exploration efforts in only two places: the Upper and Lower Zones of Lodestone Mountain.

Upper Zone

Ore Reserves -- The Lodestone Mountain Upper Zone trends northwest along the peak area for some 9,000 feet with a width of 2,500 feet. The general zone area is outlined by the 6,000 feet contour. Initial drilling has outlined an iron concentration within the Upper Zone of 2,200' strike length indicating widths in excess of 900 feet and a depth to 350 feet. The true attitude of the ore zone has not as yet been determined, principally because all holes but drill hole #7 were drilled vertically. The iron zone has not been delimited in any direction although a drop off in grade was noted in holes B-8 and B-10 indicating a possible width limitation.

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* General geologic data largely taken from the Annual Report from Minister of Mines - Province of British Columbia, 1959

** Also large quantities of placer magnetite of unknown grade are doubtless contained in the terrace gravels along the Tulameen River.

Imperial has probed the Upper Zone with twelve diamond drill holes where the grade of soluble iron ranged from approximately 12% to 24%. The holes were spotted erratically without the aid of survey and then drilled, governed largely by ease of access and dip needle readings. (See sketch map, Fig. 1) Because holes B-11 and B-12 were isolated from the other drill holes they were not considered in determining ore reserves. Indicated tonnage of recoverable iron metal from this drilling approximates 3,500,000 tons. An average depth of 250' was assumed within a general surface triangular area of a 2,200' base length and a height of 950' as outlined by drill holes B-1 through B-10. (See Fig. 2) A cubication factor of 10 was used. Because of the erratic nature of the drilling no exact attempt was made to weight the assays to areas of influence, but for purposes of calculation for this report the average recoverable iron in the ore was assumed to be 13.3% iron, representing 7.5 tons of ore required per ton of pig iron. This factor conservatively accounts for mine dilution, poorer mill recoveries than the Davis Tube results, and smelter losses. The ore body is controlled by Imperial and no royalty payments are required.

Mining Aspects -- Immediately beyond the northeast edge of the iron concentration zone along Lodestone Mountain the ridge drops off vertically for 600 feet within a horizontal distance of approximately 1,800 feet which provides an excellent point of attack for a low cost quarry operation. The ore zone is free of overburden with the exception of a foot or two of soil cover in places.

As now envisioned a primary crusher could be placed within the quarry, and the crushed ore could be chuted to the concentrating plant located on the flat below the quarry at about 5,500 foot elevation.

Based on verbal reports, Lodestone peak could be mined the year around because it is located within the interior dry belt of British Columbia. Average winter snowfall is stated to be four to five feet at 6,000 feet elevation and the summer weather is dry.

Milling -- The metallurgical testwork reported herein was done by John W. Britton, consulting metallurgist of Vancouver, British Columbia. The laboratory testwork treated the split cores from the diamond drill holes. Detailed results of each core ground to 100 mesh and concentrated in a Davis tube are shown in Table 1. A 15,000 grams composite sample of core from holes B-1 to B-6, and B-8 to B-11 also were crushed to minus 10 mesh, followed by a wet magnetic separation in a Sala machine with single cleaning of concentrate to produce 8,867 grams (59.1%) of rougher concentrate. Fifteen hundred gram samples were ground in a ball mill for periods of 5, 10, 15, and 25 minutes respectively. The pulps were then concentrated in the Sala separator and the concentrates were cleaned twice in the same machine, dried, weighed and assayed with the results shown in Table 2.

The complete analysis of head and concentrate produced after a 100 mesh grind from the composite of the first five holes (B-1 through B-5) drilled within the high grade core of the ore zone is listed in columns "A". The analysis shown in Column "B" was taken of concentrate produced from composite (B-1 to B-6 and B-8 to B-11) after grinding to 98% of minus 48 mesh material during test "C" shown in Table 2.

	"A" Head	"A" Concentrate	"B" Concentrate
Fe (total	23.4	62.5	55.99
Fe (acid sol)	20.95	62.4	54.89
TiO_2	1.80	2.5	2.96
SiO_2	33.54	5.0	10.45
Al_2O_3	3.95	1.83	2.30
CaO	13.86	1.78	3.70
MgO	11.33	1.54	3.76
Mn	0.19	0.17	0.16
S	0.01	0.01	0.01
P	0.03	0.01	0.01
Total H_2O	0.79	0.39	0.34

Note: Column "B" concentrate was also assayed for copper - 0.023% and vanadium - 0.01%.

The indicated wet magnetic milling circuit appears to have no unusual features. Approximately a 40% reject of the head feed appears possible with a 10 mesh grind to produce a rougher concentrate. Recoveries of 80 to 85% are possible. Indications are that the ore requires considerable retention grinding time to liberate the iron. As mentioned elsewhere in this report there appears to be adequate water in Lodestone Lake plus what could be dammed in drainage patterns within the vicinity of Lodestone Peak to satisfy the mill and the seven mile concentrate pipeline to the smelter located along the Tulameen River.

Lower Zone

The writer did not visit this property which consists of 23 mineral claims extending from the summit of Tanglewood Hill south to Blakeburn Creek below Lodestone Peak. The discussion of this property has been based on a report dated 4-17-62 written to Imperial by Harvey H. Cohen, professional engineer.

During 1958 a series of 12 bulldozed trenches explored the more favorable magnetic anomalies. The following year eleven 100' churn drill holes and a 525' (-45°) diamond drill hole were completed over an area of influence of 165,000 square feet. As reported by Mr. F. Price weighted average grade of all samples was 18.05% soluble iron, representing 1,840,000 tons of reserves down to 100' depth.

During 1962 ten diamond drill holes, averaging 113 feet in depth, were completed with emphasis placed to the east of previous drilling within an effective area of 250,000 square feet. Average grade was 16.4% soluble iron with reserves estimated at 3,139,000 tons. 2,848,000 tonnes In general, the best ore is concentrated within 60 feet of the surface. Preliminary metallurgical testwork by John W. Britton indicated that recoverable iron averaged but 12.5% after grinding to -100 mesh.

Based on the evidence presented in Cohen's report the Lower Zone appears to be inferior to the Upper Zone as to over-all grade, recovery, tonnage, and amenability to lowest cost mining. Possibly in the future when Imperial's plant capital costs have been written off, Lower Zone reserves can be used advantageously, particularly the richer grades near the surface.

CRAIGMONT CONCENTRATE

No investigation was made of this potential source of iron ore other than a brief discussion with the Imperial staff. Currently the Craigmont copper mine near Merritt, British Columbia is producing 5,000 tons/day of iron bearing tailing from its flotation concentrating mill. It is estimated that 600 short dry tons of iron concentrate can be produced per day with the following analysis:

	Coarse Grade	Medium Grade	Fine Grade
% minus 200 mesh	63.7	79.2	95.6
Oxide Fe	55.6	60.1	65.8
Cu	0.04	0.026	0.017
SiO_2	12.41	9.30	4.72
Al_2O_3	2.83	2.15	1.20
TiO_2	0.38	0.35	0.24
Mn	0.02	0.01	0.005
CaO	1.06	0.76	0.50
MgO	1.25	0.81	0.52
S	0.04	0.03	0.02
P	0.04	0.03	0.02

This raw material could provide Imperial with a source of iron concentrate practically free of titanium and is only a 50 mile rail distance from the proposed smelter site. Craigmont concentrate could be used independently as a smelter feed or blended with Lodestone ore to reduce its titanium content.

The cost of producing the concentrate and the amount of metallurgical testwork done on the treatment of Craigmont iron bearing tailing is not known to the writer. The assumption can be made, however, that the cost should be nominal since the raw material tailing feed will have been essentially paid for by copper production.

Suggested Action

Because of the low recoverable iron content of the ore, probably no one cost sector of this project is so important as assuring a large tonnage of the best available ore tied to the most efficient metallurgical flow sheet.

At this preliminary stage of the project when cost estimates are crude, ore reserves should not fall below an average grade of 17% sol iron to be considered potential ore feed. Any future drilling program should be carefully engineered under a recognized mining expert as to grid pattern and tonnage estimates. It would be advisable to have both aerial and ground magnetic surveys made to delineate the best drilling targets in the area before an intensive drilling campaign is initiated to be sure that no high grade ore zone has been overlooked.

When typical grade ore can be determined within the Lodestone area, a number of freight carloads of bulk ore should be tested on a prototype scale to determine the most efficient flowsheet. Ottawa or Lakefield laboratories have such equipment, but it is essential that the work be supervised by a well-known competent metallurgist skilled in developing commercial iron ore flowsheets. This testwork would provide sufficient concentrate (say 6 tons) for a 100 Kw furnace test in a Udy furnace.

COAL

Tulameen Coalfield

The writer briefly reconnoitered this coal field in attempting to assess its reserve potential. Most all the geologic and historic detail mentioned in this report was derived from W.S. Shaw's report The Tulameen Coalfield, British Columbia - Canada Department of Mines and Technical Survey, 1952, Ottawa.

According to Imperial officials, the Tulameen Coalfield is held under lease from the Canadian Government by Mr. Edward Mullin and his father of Princeton, British Columbia. For each ton extracted the government will receive 25¢. The Mullins also have agreed to a 25¢ royalty per ton to be paid by Imperial which will apply toward an unspecified purchase price.

The coal field at 3,900' - 4,300' elevation underlies an oval-shaped dome area of about 6 square miles about 2-1/2 miles southwest of the Kettle Valley branch of the Canadian Pacific railway which follows the north bank of the Tulameen River between the small towns of Coalmont and Tulameen, British Columbia at 2,500' elevation.

Five miles due southwest of Tulameen Coal field is the Lodestone Mountain iron ore prospect at 6,100 feet elevation. The coal property can be reached by a six mile dirt road from Coalmont. (See sketch map, Figure 1)

The coal basin of asymmetrically folded strata trends northwesterly with the coal beds in the southwestern limb dipping NE 20° to 35°, whereas those beds on the northeast and southeast flank dip steeply westward from 40° to 80°. Except for the northwest end, the coalfield is flanked on three sides by valleys which allow for ready access to the coal measures. The three lithological Tertiary units of the Coalfield can be summarized from bottom to top as follows: (1) 400 feet of strata composed mainly of sandstone, siltstone, and, at least locally, one or two lava flows near the base; (2) 460 feet of fine grained sediments intercalated with coal beds; and (3) 1,900 feet of mainly sandstone and granule-conglomerate.

Of the 2,364,561 tons of coal mined underground by Coalmont Collieries Ltd. between 1919 and 1940 most all came from along the southwestern rim of the coalfield for a distance of some 8,000 feet. Underground mining was extended down slope as much as 3,000 feet where excessive rock pressure and squeezing was encountered, partially related to faulting in the southwest corner of the coalfield. The miners extracted the "Main seam" which was 7.5 to 12 feet thick and overlain by 9 to 14 feet of so-called "dirty coal" which in turn is capped by a thick sandstone series. Although quite rigid the sandstone is reported to be easily ripped by a large bulldozer when removal is necessary. Directly below the Main seam is an additional 80 feet of interbedded coal, clay, and shale. The footwall of the total coal measure is a shale formation. The rank of the Main seam coal is high volatile "C" bituminous. The full extent of the exploratory work carried out in the dirty coal that underlies the Main seam is not known.

Mullins Strip Pit

This coal pit is located at the surface pillar of the abandoned underground #3 mine where the writer took a chip sample across 65 feet of the coal seam thickness where it was accessible for sampling.

Except for a 4' shaley sandstone section near the base of the coal measure, the sample was contiguous and included the dirty coal with its 1/2" to 6" shale partings between beds of coal of 1' to 12' thickness. The sample was taken to obtain preliminary evidence as to whether the so-called "dirty coal" could be utilized to reduce the iron directly or as a washed product. The analysis of the sample was as follows: total moisture 3.9%, surface moisture 3.2%, inherent moisture 0.7%, ash 23.5%, volatile matter 31.7%, fixed carbon 40.9%, sulphur 0.5%, and BTU's per lb. 10,100. This coal will require testwork to determine its amenability to cleaning to reduce the ash content <u>if run-of-mine</u> coal is not useable.* From the appearance of the coal in situ, separation of the shale would not appear difficult in a washing plant. Based on the analysis of Main seam coal, a product of 55% fixed carbon, 7 to 15% ash, and 30% volatile matter could be expected.

In a report dated 3/28/56 by K.C. Fahrni, mining engineer for Granby Mining Company, mention was made that the total thickness of the coal measures where mining was initiated at the Mullin pit was 150 feet and that the alternating coal and shale series showed excellent continuity of thickness throughout the entire open cut exposure. Mention was made that old underground maps indicated a marked flattening of the slope of the seam with depth to give a saucer-like shape to the coal formation. Fahrni states that Granby was the sole buyer of coal

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* Initial reaction by Strategic's metallurgist is that dirty coal without beneficiation could possibly be used for iron ore reduction. The contained ash could help in creating a slag volume to aid in titanium removal. The savings derived from run-of-mine coal vs. washed coal would have to be engineered before a valid conclusion could be reached.

from the Mullin strip pit and purchases to the end of 1955 were 79,095 tons for the Granby Power Plant located near the outskirts of Princeton, British Columbia some eleven miles distant from Coalmont. At the time that Granby closed down its Copper Mountain operation and the associated power plant, the strip pit was producing at the rate of 200 tons per day. The heat content of the coal delivered averaged slightly better than 9,000 BTU's per pound. Power plant stack ash showed no significant metal content. Vanadium was highest of the rarer metals with content reported between .01% and 0.10%. This assay should be checked since the vanadium content of pig iron must be closely controlled.

One area of Fahrni's report leaves the writer confused since mention is made that approximately one ton of poor coal and shale was sorted out for each ton of coal delivered to the power plant. Based upon the existing exposure (see photo, Figure 3), it is difficult to determine how selectivity was possible with a bulldozer and shovel except for the 4' sand and shale seam near the base of the coal measure. Possibly it can be explained by the initial coal measure thickness of 150 feet, approximately 50' in excess of the average given for the coal field.

Other Coal Sources

The Princeton coal field covers an area of 40 square miles and it is reported that the deposits will contain at least 300,000,000 tons of coal in relative close proximity to the Canadian Pacific Railroad. Very little development work has been done but Dr. W.S. Shaw states that the area appears to possess thick workable coals which exist within definable coal-bearing zones which should be explored by shallow bore holes and underground development. Although these seams are said to require underground extraction, they could provide fuel for electric power production should there be a desire to conserve lower-cost Tulameen coal prior to the introduction of hydro power within the area.

Another coalfield owned by Imperial is located near Merritt, British Columbia. This represents 1,272 acres of Crown Grant land for which the Canadian government receives 10¢/ton for each ton extracted. Imperial officials report that the deposit contains 54,000,000 tons of coal reserves within two 30 feet thick seams of bituminous coal. Merritt is about 50 miles away from Coalmont by rail.

Suggested Action

Although the Tulameen coal field has been worked for many years, little reliable technical information was preserved. Development of assured reserves by regular interval bulldozer cuts to expose the coal measure along the periphery of the coal basin and core drilling at depth is essential. An example of such work was shown to the writer by Ed Mullin. At the northwesterly end of the basin, 200 foot bulldozer cuts of three to four feet depth exposed approximately a 100' thick contiguous coal measure over a strike length of some 1,500 feet. The coal measure has been exposed over the past forty years by cuts and adits at erratic intervals along the peripheral 28,000 feet of the basin, but no detailed engineering study has been made as to what tonnage is amenable to low cost open cut extraction. Nor has there been an assessment made as to what percentage of the total coal measure can be utilized for iron reduction and/or power production. Until the Mullin pit operation, production was geared to lump coal. A study should also be made as to whether a central coal cleaning plant and a short pipeline is desired if run-of-mine coal proves to be undesirable. Assessment should also be made as to whether the Tulameen coal should be worked underground for thermal power generation. When Imperial decides to determine assured reserves of usable coal and the most efficient technique for extraction, a recognized open pit and underground coal expert should engineer this phase of the study.

Using the conservative assumptions of a 100 foot thick coal measure of 80% usable coal mineable 100 feet down dip from the coal basin rim with a strike distance of 20,000 feet, 6,800,000 tons of open pit coal can be inferred. This tonnage of open cut coal for iron ore reduction would represent approximately 38 year life for a 300,000 ton per year pig iron smelter. This estimate does not include mineable underground indicated reserves within the Tulameen coalfield.

LIMESTONE - POWER - TRANSPORTATION

The writer's comments relating to sources of limestone and availability of power and transportation are based upon reports and/or statements made by Imperial personnel.

LIMESTONE

Imperial controls the mineral rights to a limestone deposit located 2-1/2 miles southwest of Clinton, British Columbia on the main line of the Pacific Great Eastern Railway some 120 miles north-west of Coalmont. The limestone is in the form of travertine or tufa and averages 99.2% calcium carbonate. The true extent of the deposit is unknown but the outcrop dimensions are 850' x 500' and the inferred tonnage is reported to be 4 to 5,000,000 tons. 92P 079

Reports claim a limestone occurrence a few miles north of Otter Lake which would represent a relatively short truck haul to the proposed smelter site. Also mentioned is an occurrence 21 miles north of Princeton, and a deposit near the Craigmont Copper mine about 50 miles distant by rail from the smelter site.

An assured source of limestone is the Cheam Mountain deposit with very large reserves located about 15 miles west of Hope, British Columbia and approximately 80 miles from Coalmont by rail. This property is currently operating.

Suggested Action -- The Otter Lake occurrence should be immediately investigated and field samples taken to determine its feasibility because of the potential transport savings which could be derived from such a location. The reported Princeton and Craigmont limestone deposits should also be sampled if the Otter Lake occurrence proves unattractive.

The proximity of iron ore, coal, and limestone represent the key to an economically successful iron and steel complex because of the large tonnages of raw material to be moved. A nearby source of limestone is important since approximately 0.6 of a ton is consumed for each ton of pig iron produced. If limestone is close at hand, it is desirable to calcine at the smelter site because excess by-product furnace gases can be used to fire the kiln to produce low cost lime. When Imperial's coal and iron reserves have been assured, it would then be appropriate to prove up limestone reserves by drilling.

POWER

Assuming a 53% iron concentrate, approximately 1,300 Kw/hr of electricity for each ton of pig iron produced will be consumed. Thus the availability of low cost power in quantity is of great economic significance to this project.

Potentially the Columbia River basin development can provide a large block of low cost hydro-power in the area if and when the existing differences of viewpoint can be settled between the British Columbia Provincial government and Ottawa.

The Peace River Power Project is now underway with a 1968 target date for completion. During the interim period Imperial is considering the generation of thermal power at the smelter site between Coalmont and Tulameen, British Columbia. Imperial officials report that they can purchase Granby's 19,000 Kw steam electric plant at Princeton for $175,000. Plant capacity can be increased 10,000 Kw by the addition of equipment costing $750,000 which in total could supply adequate power for a 100,000 to 150,000 ton/year integrated pig iron smelter plant. It is estimated that to move the plant to the smelter site an additional $900,000 would be required. A thermal power plant at Coalmont would logically use Tulameen coal, preferably the underground reserves to conserve the inexpensive strip coal for iron ore reduction. Possibly it might prove preferable to leave the thermal plant at its present location and erect a 12 mile power line to the smelter. Coal for thermal power generation would then be mined near Princeton.

TRANSPORTATION

Rail and Ocean Transport -- A branch of the Canadian Pacific railroad passes through Princeton, and on through Coalmont and Tulameen between which the proposed smelter site is to be located within 7 miles of iron ore and 2-1/2 miles of coal. The smelter would be 175 miles from Vancouver via the Brookmere cut-off route which is not now in service. When in production the Coalmont smelter should generate enough railroad freight business to warrant opening this short cut which saves approximately a 100 mile haul to Vancouver as compared to the present routing via Merritt and Spences Bridge, British Columbia.

Imperial officials are tentatively anticipating a $3 freight haul to Vancouver for pig iron and/or steel ingot. Because existing ocean ship-loading facilities at Vancouver for metal ingot are not satisfactory a $3 loading charge is contemplated. Ocean freight to Japanese docks is estimated at $6 per ton. Mention was also made that the expense of barge traffic from Vancouver along the West Coast of the United States was nominal.

Auto and Truck Roads -- A good eleven mile gravel road which is now being "black topped" connects Coalmont with Princeton located along the south provincial highway. The six mile truck road from Coalmont to the Tulameen Coalfield is in fair condition and can readily be made into a serviceable road. The dirt road beyond the Coalfield to Lodestone Mountain is rough and in spots can only be traversed by a 4-wheel drive vehicle. Sections of the road were recently bulldozed to gain access to the iron property with drilling equipment. If a major exploration program is begun, a new road with proper grades will probably be necessary.

Pipe Lines -- Particularly because of the low iron content of the ore it is desirable to move the iron concentrate to the smelter at minimum expense. This writer agrees with the proposal of Norman D. Lea and Associates, consulting engineers, that a seven mile pipe line convey the concentrate produced at an elevation of about 5,500 to a discharge point at the smelter in Tulameen valley at 2,500 elevation. A number of operating mine plants utilize such a technique successfully, particularly where good consistent downhill gradient prevails as is indicated by the Coalmont area topography. Fortunately, Lodestone Lake at nearly 6,000 feet elevation (within 4,000 feet of the projected concentrating mill site) with proper damming of nearby drainage patterns should provide adequate water for both mill and pipe line.

The projected iron concentrate pipe line will cut across the Tulameen Coalfield at 4,000 feet elevation, and should a coal washing plant be desired a parallel pipe of say 2-1/2 miles in length might be considered to provide low cost coal transport to the smelter site. Water would probably be pumped from Blakeburn Creek for both the coal pipe line and washing plant. Water flow from this source is not known by the writer.

SMELTING PROCESS

General

Because Imperial's Lodestone iron concentrate contains approximately 5% TiO_2, its coal is non-coking, and existing markets are relatively limited, the conventional blast furnace - coke oven facility is not feasible for this project. Although other processes could be used, the Strategic-Udy process initially appears to have greatest merit for the following reasons:

1. Utilizes non-coking coal.
2. Ability to treat titaniferous bearing ores and concentrate, and to directly produce a pig iron ingot which can readily be made into a standard grade steel.
3. Ability to utilize coal and iron concentrate without the necessity of agglomeration or pelletizing.
4. Utilization of electric power in an area which has abundant potential hydro electric power.
5. Possibility of creating an economic pig iron-steel unit of only 300 ton/day in areas where markets are limited.
6. Allows for flexibility in plant utilization of different ores. The Udy furnace unit has demonstrated its ability to produce FeMn, FeCr, and FeNi.
7. Strategic Material Corporation possesses facilities whereby large scale test runs can be made to produce pig iron and steel utilizing Imperial's iron ore, coal, and limestone.
8. Strategic is currently operating a commercial ferrochrome plant at Niagara Falls, Ontario. Although this 10,000 Kw

furnace unit was designed for ferrochrome, prior to the chrome runs some 4,000 tons of conventional iron ore were fed to the kiln-furnace unit successfully producing pig iron and indicating good thruput, power consumption, and the maintenance of grade.

Barring internal civil strife within Venezuela, a 33,500 Kw Electrokem submerged arc furnace will be converted by January 1963 to the Strategic-Udy process to treat Orinoco iron ore. Koppers Company, Inc. is currently engineering the conversion which will provide commercial evidence of the Udy process in a unit designed for iron ore utilizing the largest existing electric furnace in the world.

Based on existing process evidence Koppers will erect a smelter plant on a "turn-key" basis guaranteeing specification of product and annual tonnage produced. Koppers possesses the first right of refusal to engineer and design the smelting plant assuming it can match the bid of any other contractor. Strategic Materials Corporation obtains its remuneration solely through ownership of the process and has shown flexibility in its willingness to share in a project's equity or the charging of a royalty. Royalty applies to the pig iron output for which a $1.25 per ton charge should be contemplated.

Suggested Action

Step 1 - To obtain an initial feasibility of the process and project, representative six ton samples of the concentrate from Lodestone Mountain and/or Craigmont should be processed through a 100 Kw furnace by Strategic Materials Corporation. The concentrate samples would be produced from mill testwork to determine the most efficient upgrading flowsheet at Ottawa, Lakefield Research, or similar type prototype testing facility. One hundred kilowatt furnace testwork would provide good evidence as to titanium elimination when attempting to hold carbon and silicon specifications for a merchant pig iron made from solely Lodestone concentrate and/or a blend with Craigmont concentrate. If only steel products are to be produced and sold by Imperial the specification demands of the pig iron to be used captively appear to be readily attainable although confirming tests should be made.

Strategic has run so many titaniferous iron ores through their 100 Kw lab furnace, 1,000 Kw prototype furnace, and 10,000 Kw commercial furnace that significant preliminary data can be deduced from a small 100 Kw lab run. This testwork should be done immediately after a typical grade run-of-mine ore is determined and is available in sufficient quantity to warrant the project. This would provide Imperial with an excellent understanding as to what pig and steel products it can expect to sell and the anticipated cost of such items.

Step 2 - Assuming Step 1 and detailed feasibility studies prove satisfactory as to marketing, power, and iron ore-coal-limestone reserves, Imperial should make large scale (1,000 Kw) tests at Niagara Falls, Ontario and ship typical iron ore to the 50 T/D magnetic upgrading plant at this prototype smelter site. Sufficient ore should be shipped to produce enough concentrate for at least a ten day continuous smelter run. Typical Coalmont coal should also be shipped in adequate quantity for this test run. It would probably not be necessary to utilize British Columbia's limestone for the tests, unless the raw limestone is to be injected into the kiln contemporaneously with the coal and concentrate. If the limestone is to be calcined prior to introducing it to the kiln, calcining tests in British Columbia should prove adequate.

MARKETING

Basic Pig Iron

Except for Consolidated Mining and Smelting's pig iron production from base metal ore tailing at Trail, British Columbia,* there is no integrated iron-steel production throughout the Western Provinces of Canada and the Pacific Northwest of the United States. This environment invites the creation of an integrated producer providing pig iron and steel can be produced competitively with scrap-fed furnace operations and distant integrated production.

Except for Kaiser Steel Corporation of Southern California, iron and steel products of the far west are being produced in cold charge furnaces (basic and acid open hearth, cupola combinations, and/or electric) which do not have access to fluid iron from captive blast furnaces. To a large extent these cold charge operations use large quantities of scrap, particularly when scrap prices are low. Located close to a source of coking coal, a blast furnace can produce molten pig iron for approximately $45 per gross ton. Steel scrap prices fluctuate greatly but have in the past seven years averaged between $35 to $40 per gross ton. To a significant extent the price of steel scrap is related to integrated steel plants. When there is an increasing percentage of pig iron fed to open hearths and convertors, the demand for scrap steel decreases and prices drop. With the softening of iron ore prices, improved blast furnace techniques, a greater supply of molten

* It has been reported to this writer from a reliable secondary source that Cominco is seriously considering expanding pig iron production and initiating steel production. If true, this development bears close watching because of the availability of low cost iron units, electric power, and the Company's close tie-in with the railroad.

pig iron is available to feed steel furnaces without additional capital expense for blast furnaces. The net result is that scrap prices are trending downward. Currently #1 melting scrap is selling for $30-$32 delivered at the mill in Seattle. With these scrap prices and relatively low capital costs compared to an integrated producer, the scrap melter provides serious competition particularly in areas of relatively limited consumption and where flexibility of output is desired.

Scrap melters are, however, in an unprotected position when the price of steel scrap increases. In the case of carbon tool steel and specialty products, the melters have an additional problem with tramp elements such as nickel, chrome, copper, lead, and tin, found in scrap which cannot be removed inexpensively from the melt. Melters of lower quality steels can obviate their impurity problems by lacing their scrap melts with quality pig iron to dilute the tramp elements to nominal levels. Undoubtedly some Imperial pig iron could be sold for this purpose, but the tonnage would not be great unless sold at a significant discount below normal pig iron prices.

Producers of quality products, however, such as carbon tool steel are greatly concerned with tramp residual elements which cause them trouble. Their optimum raw material is a segregated low phosphorus steel scrap which includes railroad scrap and plate normally selling at about a $5 premium per gross ton over #1 grade heavy melting scrap. Imperial's potential pig iron product would be ideally suitable for specialty steel makers because of minimum content of tramp elements.

Foreign Markets for Pig Iron

Imperial's largest immediate outlet for pig iron appears to be Japan, a country with high cost poor quality coal, relatively poor grade iron ore resources, and vigorously growing steel industry. Japan has set an annual production target of 45,000,000 tons of crude steel by 1970. Japan's iron and steel industry is strong on facilities but weak on resources, resulting in the importation of about three quarters of its primary iron materials and approximately half of its coking coal. Recent Japanese efforts to produce and/or buy pig iron from the Union of South Africa and Brazil indi cate a trend to import their iron in metal form rather than concentrate if the pig can be purchased at "bargain basement" prices. Imperial's potential smelter site being but 175 miles by rail from Vancouver offers an excellent location for exports to Japan. The principal question to be answered by Imperial is whether it can profitably sell pig for the assumed current bid price of U.S. $49 per metric ton c.i.f. port of Japan.

As a general rule, a sulphur content of 0.035% and a maximum titanium content of about 0.10% are required today for easy marketing. The specification of pig iron desired by Mitsubishi International Corporation dated 5/8/62 is as follows:

Carbon	3.5%	minimum
Silicon	1.2%	maximum
Manganese	0.8%	minimum
Phosphorous	0.3%	maximum
Sulphur	0.05%	maximum
Copper	trace	

Since Imperial's magnetite concentrate contains but 0.17% Mn, ferro manganese additions would be required to meet the above specifications which, of course, would increase pig costs. Normally with titaniferous ores it is desired to keep the silicon content moderate to properly eliminate the titanium present in the concentrate. Only metallurgical tests will satisfactorily answer the question whether a 3.5% carbon and about an 0.8% silicon pig can be made without retaining too high a titanium content.* The silicon can be kept low in the initial melt for titanium removal, and subsequently added but at extra cost.

Should Craigmont concentrate be used for the manufacture of basic pig iron little difficulty will be encountered in maintaining the proper percentages of carbon and silicon because of the concentrate's low titanium content. If desired Craigmont concentrate could be blended with Lodestone concentrate to reduce the over-all titanium content to more readily meet merchant pig specifications.

Foundry Iron

The Canadian market for merchant pig iron is almost entirely in the iron foundry industry (essentially the eastern Provinces) which is estimated to consume 400,000 tons by 1965 and 500,000 tons by 1970. The producers of gray iron and steel castings in Canada and the U.S. consume approximately 5,000,000 gross tons of pig iron annually for cold charges to cupolas and open hearth furnaces. Roughly 2,150,000 gross tons is consumed in Illinois, Michigan, and Ohio - representing the greatest concentration of this industry in North America. Foundry

* A preliminary review of the total chemical analysis of 62.5% Fe concentrate from Lodestone (see pp.5 of this report) by Strategic's technical staff indicates that titanium of Lodestone pig can be held at 0.1% with silicon holding at 0.75%. A small addition of carbon might be needed to maintain a 3.5% grade. Where a pig iron is to be melted within an electric furnace for steel manufacturing a low carbon and silicon is desired which is ideal for handling titanium.

iron demands close specifications which is why large quantities of virgin metal is desired, but by the same token a potential producer must carefully determine his metallurgy and economics since generally ladle additions are required to attain the desired chemical composition which adds to the cost of metal. The foundry iron market is a significant consumer of iron and should be thoroughly investigated by any potential iron producer.

Ductile Iron

Ductile iron is produced by the innoculation of cast iron with magnesium-cerium alloys just prior to pouring. The addition modifies the form of graphitic carbon increasing the ductility of the finished product. Ductile castings are no more than ten years old commercially, and only during the past two or three years has it gained acceptance in the field of design and engineering. The present rate of North American ductile metal production is estimated at 350,000 - 400,000 tons per year (tonnage of finished castings only half that figure), in which 100,000 tons of premium grade low phosphorous pig iron is used. Even this high grade blast furnace product, however, does not adequately meet the needs of the industry which lays great stress on production control and uniformity of materials. It has been estimated conservatively based on statements of International Nickel Company that the rate of growth in ductile iron castings would be 50% by 1965, with a 100% increase by 1970. Because of the indicated low phosphorus and sulphur content of Lodestone ore, Imperial should be able to make an excellent product for ductile iron manufacture.

Steel Products

From the preceding discussion of iron products it can be seen that except for ductile iron, Imperial's pig product will probably require additives to meet consumer requirements. This is not peculiar to just Imperial's iron concentrate but it should be fully understood when surveying the economic validity of the entire project.

One of the attractive features about steel production is that the projected pig product produced by Imperial would be ideally suited for hot metal feed directly into an electric steel furnace. Thus for say $13 a net ton direct cost above the pig iron cost, quality carbon steel billets could be produced by conventional steel refining and continuous casting methods.

Prices of steel billets cast for use by blooming mills generally range between $70 to $90 per ton delivered.* However, these ingots can be sold only to companies with excess rolling capacity over melting capacity such as Canada's Interprovincial Steel and Pipe Company.**

It normally costs $5 per ton to heat a cold steel ingot up to rolling mill temperature. This cost would have to be borne by the producer of steel ingot. There is no such thing as a standard ingot size. Each blooming mill will require its own size of ingot steel. Furthermore the composition of a steel ingot will depend upon the final product which is to be made from the ingot. Imperial should make a

* Ordinary ingot steel of the following analysis: .03% phosphorus, 0.1% carbon, 0.1% silicon, 0.2% manganese, and 0.3% sulphur would command only a $7 premium over conventional scrap prices. In short it would be considered premium grade steel scrap.

** Given adequate spare parts the melt capacity is about 10,000 tons/month while the rolling mill has a 30,000 ton/month capacity.

serious investigation with the Japanese whether steel ingots of proper specification and cast to size for their rolling mills could be sold for say approximately $75 shipped to their docks. If so, the need for meeting open hearth pig specifications are bypassed, Imperial would receive a better return on their investment, and the Japanese would receive an upgraded product which would obviate substantial capital investment in their expansion program. Japanese financial participation in the project would greatly help in attaining Japanese acceptance to this concept.

Probably the easiest route for Imperial to enter fabricated steel products is the production of finished steel reinforcing bars at a direct cost of about $17 above carbon steel billet. Located in the heart of projected hydro power development the consumption of rebar should be substantial.

There is no doubt that Imperial's most lucrative area for capital expended would be the reinforce and merchant bar type of product as compared to pig iron and steel billet. These fabricated shapes command a price of approximately $110 - $130 per ton which could provide attractive cash flow and payout possibilities. Because of existing markets and rebar capacity, Imperial could consider only a portion of its steel output in fabricated shapes and the balance in billet form for rolling mills lacking hot metal capacity.

It is estimated that during 1959 Alberta, Saskatchewan, Manitoba, and British Columbia consumed approximately 300,000 tons of basic iron and steel product,* excluding pipe, of which British Columbia took

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* Reinforce and merchant bars, heavy and light shapes, plate and skelp. Iron and steel utilized in foundries have not been included.

71,642 tons. (See Tables 3-6). During the same period the states of Washington and Oregon consumed 406,000 tons plus 81,000 tons of pipe and tubing.

Although the California market may not prove attractive because of freight duties, and the proximity of Kaiser Steel output, the state consumed during 1959 an estimated 1,580,000 tons of basic iron and steel products plus 332,000 of pipe and tubing. As with the Canadian statistics no foundry product consumption has been included.

PROJECTED MANUFACTURING AND CAPITAL COSTS FOR PRODUCING PIG IRON AND STEEL INGOT (Canadian Dollars)

General

For anyone to project costs for Imperial's embryonic steel and iron project is dangerous and the estimates must be taken with caution. However, Imperial should have a reference point so that it can ascertain the potential financial prize before entailing pre-production expenditures. The writer has purposely tried to be on the high side of costs to determine the feasibility of the project against rigid standards that are still within the range of current engineering practice. Obviously a myriad of assumptions have been made regarding tonnage and grade of reserves, power, milling, smelting and transport which have yet to be proven, as explained in detail within other sections of this report.

Manufacturing Costs

This writer believes there are good possibilities of reducing these direct costs, particularly as to iron ore, coal, limestone and power. The tabulation below assumes a 100,000 to 150,000 net ton per year pig iron plant.

	Cost per net ton of hot metal
Fe Ore - 7.5 tons x $1.10/ton (70¢ milling & 40¢ mining)	8.25
Coal - 0.60 tons x $3.50/ton (including coal royalties)	2.10
Limestone (not calcined) 0.60 tons x $3.00/ton (delivered to plant)	1.80
Power - 1300 kw-hr/ton of pig x $0.006/kw-hr (53% iron conc.)	7.80
Electrodes	2.00
Miscellaneous (special fluxes, fuel oil, etc.)	1.00
Total cost of materials	22.95
Total overhead and operating expense*	8.00
Total mfg. expense to produce 1 net ton of hot metal pig iron	30.95**

Note: The above costs are exclusive of interest, depreciation, process royalty, taxes, administration expense, interest on working capital or any other fixed charge.

The direct cost of producing continuous cast refined steel billet from hot pig metal will add approximately $13 per net ton above the manufacturing cost of producing hot metal pig. Rebar steel will add about $17 per ton direct cost above that of steel billets.

Capital Costs

These preliminary capital cost estimates are crude and are not designed for exactness, but, like the manufacturing costs, they will provide Imperial with a bench mark in the determination of the cash flow required per net ton of metal to create a doable project. The writer has chosen a 150,000 net ton per year smelter operation for detail presentation because power requirements are within the capacity range of available low cost thermal power facilities.

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* For capacities in excess of 200,000 tons per year, total overhead and operating expense can be assumed to be $5.00. Thus a 300,000 ton/year plant would indicate a manufacturing expense of $27.95.

** Add 50¢/ton if metal is to be cast into pigs.

Iron mine plant - 3,200 tons/day	$ 650,000
Iron concentration plant - 3,200 T/D x $1,100	3,500,000
Iron concentrate pipeline - 7 miles x $50,000/mile	350,000
Coal mine equipment	255,000
Coal washing plant - 600 T/D x $700	420,000
Coal pipeline - 2.5 miles x $50,000	125,000
29,000 KW power plant - including used equipment	2,000,000
Pig iron smelter plant - 150,000 tons/year x $60/ton*	9,000,000
Working capital and pre-production development exp.	2,700,000
Estimated capital cost	$19,000,000

Note: The estimated capital cost for a 300,000 ton/year integrated pig iron plant would be $37,600,000 assuming total thermal power requirements will cost $6,500,000.

The additional capital cost beyond a pig iron plant to produce continuous cast steel billet approximates $25 per ton of yearly capacity. Thus, total capital cost of 150,000 ton/year integrated steel billet plant would approximate $22,750,000 and for a 300,000 ton/year unit - $45,100,000. A rebar mill addition would bring total capital costs to $25,000,000 and $49,600,000 for the respective plant capacities.

Comment

It is to be noted that although projected direct costs are low by competitive standards, capital costs are high because of the need of installing mine and mill plants for iron ore and coal, pipelines, thermal power facilities, plus a smelter and refining plant.

To provide a doable package for financial and corporate circles, this project should show at least a 7 year payout on the capital required. The tabulation below shows the indicated cash flow requirement per ton of metal sold for a 150,000 ton per year plant at Coalmont, British Columbia.

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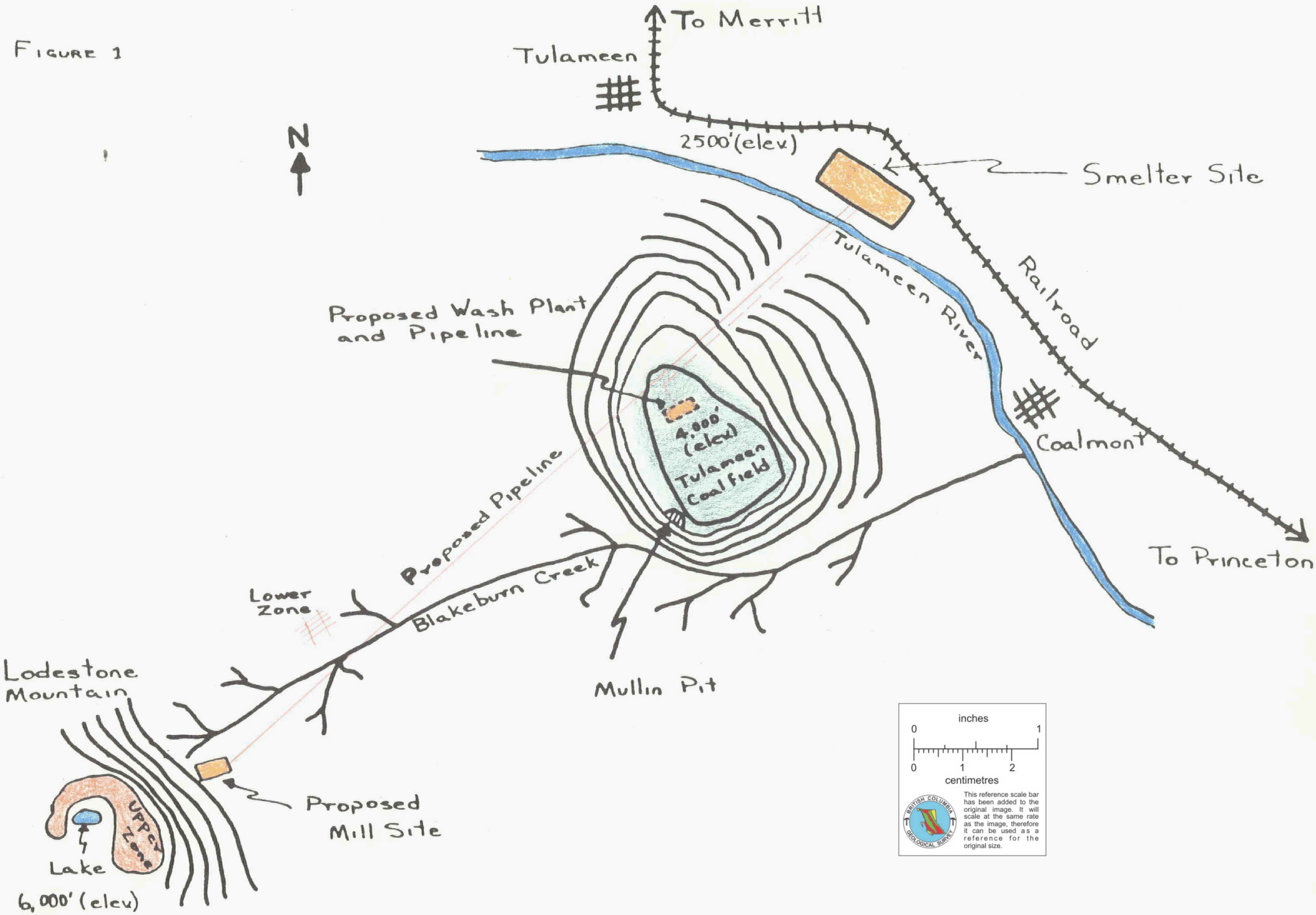
* This does not include expenditures for land, railroad spurs, fences, sewerage, laboratories, and any unusual plant foundation preparation expense.

Product	Cash flow required	Indicated direct cost	Approx. selling price range of product	Price-direct cost spread
		Canadian Dollars		
Pig iron	$20/GT	$35/GT	$52 to $76/GT	$17 to $41
Steel billet	$22/NT	$44/NT	$76 to $98/NT	$32 to $54
Rebar	$24/NT	$61/NT	$120 - $141/NT	$59 to $80

These cash flow requirements could be modified to some degree if senior long term money is willing to allow equity shareholders a priority payout. This, however, does not alter the desired maximum seven year target in the current money market for a project of this kind. Even this payout schedule is a concession given because of the inherent high capital cost characteristic of the iron and steel business and the opportunities for market growth in Western North America.

Figure 1


To Merritt
Tulameen
N
2500'(elev)
Smelter Site
Tulameen River
Railroad
Proposed Wash Plant and Pipeline
4,000' (elev)
Tulameen Coal field
Coalmont
To Princeton
Proposed Pipeline
Blakeburn Creek
Lower Zone
Mullin Pit
Lodestone Mountain
Upper Zone
Lake
6,000' (elev)
Proposed Mill Site
inches
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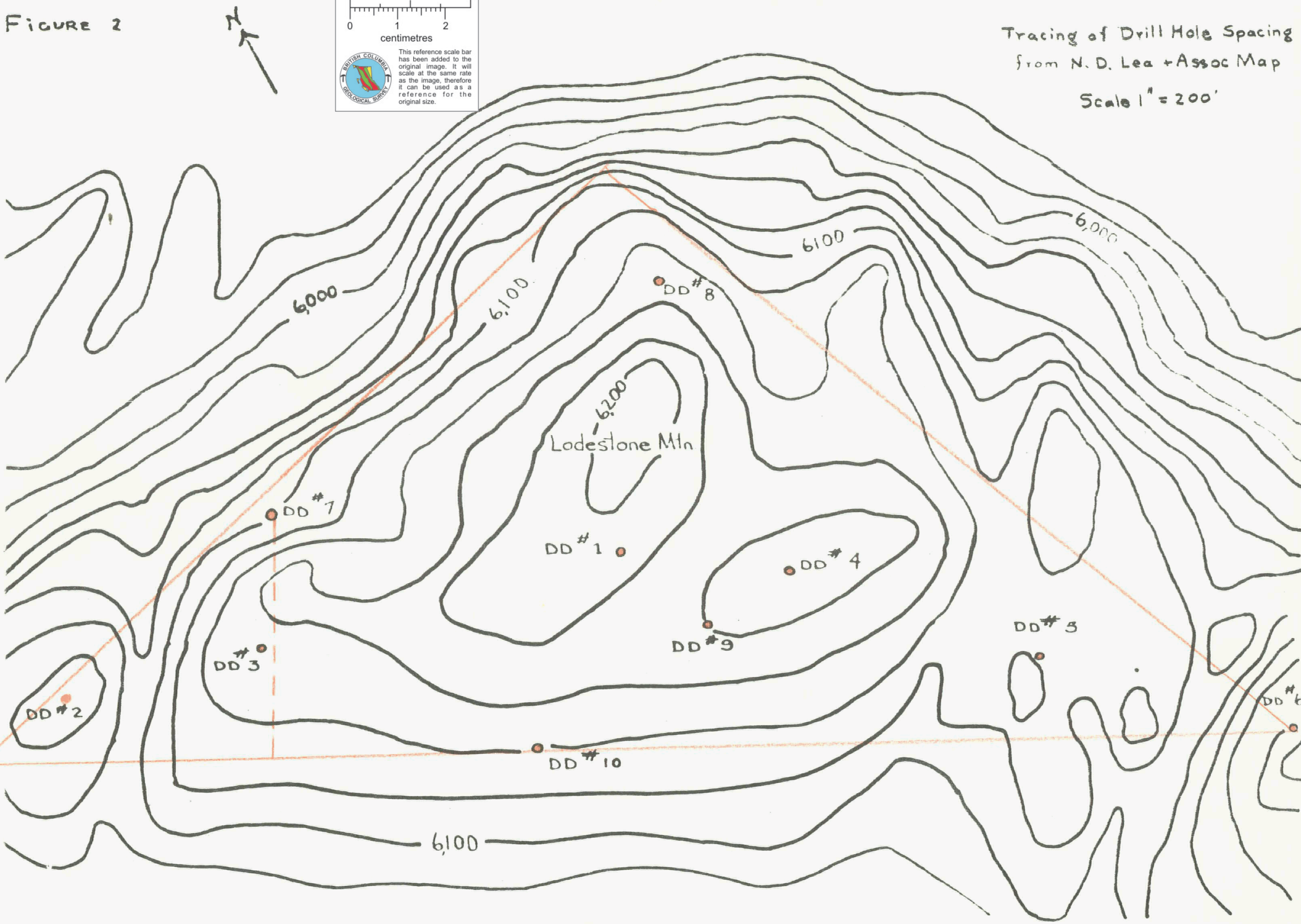
BRITISH COLUMBIA GEOLOGICAL SURVEY
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

Figure 2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N
Tracing of Drill Hole Spacing
from N. D. Lea + Assoc Map
Scale 1" = 200'
6,000
6,100
6100
6,000
6,200
Lodestone Mtn
DD #8
DD #7
DD #1
DD #4
DD #9
DD #3
DD #2
DD #5
DD #6
DD #10
6,100

Mullin Pit Coal Measure. Note broken coal on old benches and man standing at toe of exposure.

Looking Southeast along the top of Lodestone Mountain -- Upper Zone

Looking Northeast toward Coalmont from Lodestone Peak

Figure 3

TABLE 1

Upper Lodestone Davis Tube Magnetic Concentrating Tests at Minus 100 Mesh Grind

Hole No.	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
Footage	0-13 29-130	0-100 130-240	0-100	0-98	0-132	0-330	0-444	0-196	0-259	0-100	0-100	0-130 140-150
No. of feet	114	210	100	98	132	330	444	196	259	100	100	140
Head assay % sol. Fe	20.56	19.86	24.25	20.86	20.36	16.47	19.86	17.37	19.96	15.47	14.17	16.97
Conc. wt. %	29.1	28.2	34.7	28.8	30.0	26.1	26.2	25.6	27.0	22.0	21.1	23.1
Ratio of conc.	3.44/1	3.55/1	2.88/1	3.47/1	3.33/1	3.83/1	3.82/1	3.91/1	3.70/1	4.55/1	4.74/1	4.33/1
Conc. assay % sol. Fe	61.68	60.38	64.87	63.37	58.68	51.90	63.87	55.39	63.97	58.58	53.89	61.18
Fe recovery %	87.3	85.7	92.8	87.5	86.5	82.3	84.3	81.6	86.5	83.3	80.2	83.3
Recoverable Fe %	17.9	17.0	22.5	18.3	17.6	13.5	16.7	14.2	17.3	12.9	11.4	14.1
Tons of ore for 1 ton of recoverable Fe	5.59	5.88	4.44	5.46	5.68	7.41	5.98	7.04	5.78	7.75	8.77	7.08

TABLE 2

Magnetic Concentration Tests Using a -10 Mesh Grind to Produce a Rougher Concentrate Before Fine Grinding*

	Test A	Test B	Test C**	Test D***
Concentrate grinding time-minutes	5	10	15	25
Final concentrate weight-% of rougher (-10 mesh) concentrate	66.1	53.9	48.7	44.5
Final concentrate weight-% of original ore	39.1	31.9	28.8	26.3
Ratio of concentration	2.56/1	3.13/1	3.47/1	3.80/1
Assay of ore % soluble Fe	18.66	18.66	18.66	18.66
Assay of rougher concentrate (-10 mesh) % Fe	27.74	27.74	27.74	27.74
Assay of final concentrate % soluble Fe	41.02	49.30	54.89	59.48
Overall iron recovery %	86.9	85.2	85.7	83.9
Recoverable iron %	16.2	15.9	16.0	15.64
Tons of ore for one ton of Fe (app.)	6.2	6.3	6.3	6.39

* These tests were made from the weighted composite sample of core from holes B1 to B6 and B8 to B11.
** Final concentrate contained 98% of -48 mesh material.
*** Final concentrate contained 95.6% of -100 mesh material.

TABLE 3

Estimated 1959 Western Canadian and U.S. West Coast Supply Picture for Concrete Reinforcing Bar, Merchant Bars, and Light Shapes

Location	Capacity		Consumption	Source of Supply
Canada				
British Columbia	60,000		45,000	Vancouver Rolling Mills
Alberta	79,000			Premier Steel Mills
Saskatchewan		-------	112,000	
Manitoba	53,000			Manitoba Rolling Mill
U.S.				
Washington	177,000			Northwest Steel Washington Steel
		-------	220,000	
Oregon	93,500			Oregon Steel Mills
California	1,096,000		741,000	Twelve different Co's.

Note: Total consumption of this class of product including concrete reinforcing bars and merchant bars and light structurals (rounds, flats, squares, angles, and channels) used for construction and industrial items.

TABLE 4

Estimated 1959 Western Canadian and U.S. West Coast Supply Picture for Plates and Skelp

Location	Capacity	Consumption	Source of Supply
Canada			
British Columbia	---	21,000	
Alberta	---		
Saskatchewan	90,000	86,400	Interprovincial Steel
Manitoba	---		
U.S.			
Washington	18,000	111,000	Bethlehem Steel
Oregon			
California	1,065,000	659,000	Kaiser Steel Corporation

Note: This product represents heavy flat products used for line pipe, industrial equipment, railroad cars, ships and construction items. There was no production in Western Canadian Provinces until mid - 1960.

TABLE 5

Estimated 1959 Western Canada and U.S. West Coast Supply Picture for Pipe and Tubing

Location	Capacity	Consumption	Source of Supply
Canada			
British Columbia	130,000	Unknown (Canada total)	Canadian Western Pipe Mills
Alberta	550,000		Alberta-Phoenix Tube and Pipe Camrose Tubes Big Inch Pipe and Plate
Saskatchewan	60,000		Prairie Pipe
Manitoba	---		
U.S.			
Washington	---	81,000 (Washington and Oregon)	
Oregon	---		
California	1,145,000	332,000	Ten different Co's.

Note: Pipe mill products are of two types: seamless pipe made from tube rounds and welded pipe made from plate or skelp. The better technique is used in Western Canada. About 2/3 of total Canadian pipe requirements are normally consumed in the four Western Provinces.

TABLE 6

Estimated 1959 Western Canada and U.S. West Coast Supply of Heavy Structural Shapes

Location	Capacity		Consumption	Source of Supply
Canada				
British Columbia	---		5,642	
Alberta	4,000			Premier Steel Mills
Saskatchewan	10,000	-------	32,000	Interprovincial Steel
Manitoba	15,980			Manitoba Rolling Mills
U.S.				
Washington	40,000			Bethlehem Steel
Oregon	16,000	-------	75,000	Oregon Steel Mills
California	314,000		180,000	Five Co's.