006538

BRYNNOR MINES LIMITED

PROPERTY FILE 92F001 - 04

GEOLOGY

Setting

THE Brynnor magnetite deposit is in a northeasterly striking belt of Triassic Vancouver Group andesite, tuff and limestone. The belt, two miles in length by a half-mile in width, is surrounded by Jurassic quartz diorite intrusions and cut by numerous feldspar porphyry and granitic dykes. The Vancouver Group rocks are strongly folded and have the appearance of forming a synclinal structure with a shallow dip to the north-northeast. However it seems probable that the volcanic and sedimentary rocks are in fact a "roof pendant" lying in Coast Range quartz diorite.

Rock Types

Limestone forms the core of the Triassic rocks and may be the younger unit. Its true thickness is exaggerated by very strong drag folding.

Tuffaceous rocks are commonly in contact with the limestone and may underlie it conformably. Andesite appears to be the older rock unit but is found in contact with both the tuff and limestone.

The Triassic rocks are surrounded by quartz diorite and cut by dykes of the same composition. The rock is medium to coarse grained and relatively fresh.

Numerous feldspar porphyry dykes cut the magnetite and all other rocks. The most common attitude is a northerly strike and steep to vertical dips.

Alteration

The limestone has been thoroughly recrystallized with coarsely crystalline lenses occurring in the generally fine grained rock. Irregular masses of garnet skarn have been formed in the limestone, particularly near its contact with the tuff.

The tuffaceous rocks have undergone strong pyroxene-garnet alteration. This process has been much more intense along the limestone contact and near the quartz diorite batholith.

Faulting

Prominent post-ore faulting has occurred in the orebody. Two parallel faults strike northwesterly and dip flatly northeasterly but show little if any displacement where they cut the ore. A strong northerly striking fault along the eastern limits of the open pit dips steeply to the west. It has caused a large downward displacement of the ore to the east thus placing these reserves below the limits of economic open pit mining.

Controls

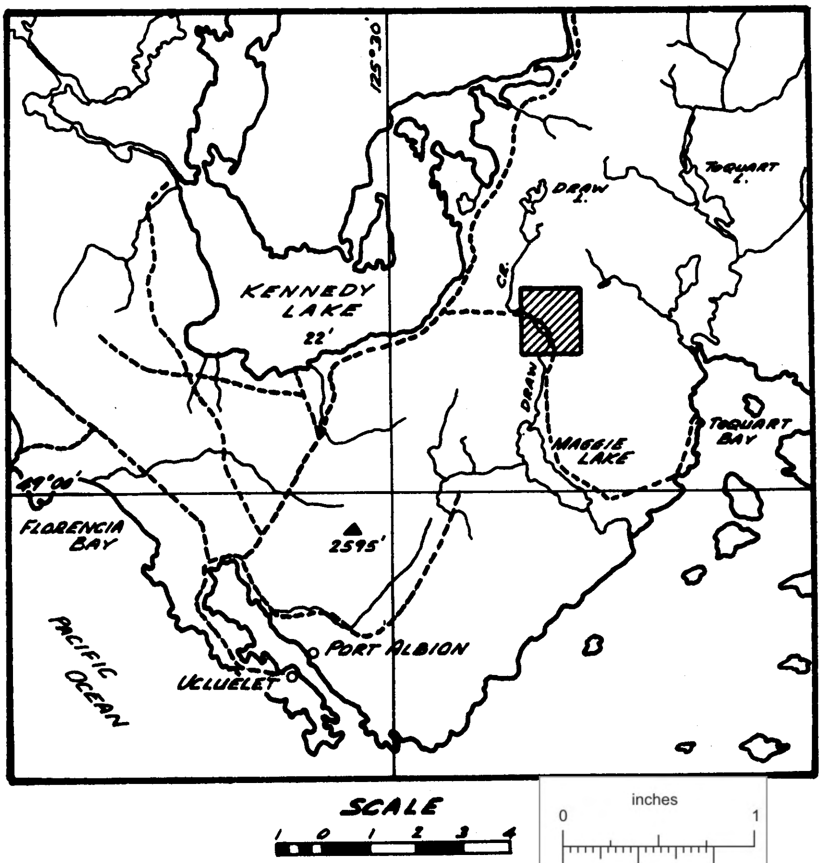
The primary strutcure of highly folded Triassic rocks in Coast Range quartz diorite provided a favorable setting for mineral deposits. Principal ore controls within the structure are the tuff-limestone contact and the intense drag folding which has occurred within the lime. The strong pyroxene-garnet alteration preceded ore deposition and is a result of the mineralizing process. It may have exerted some influence over ore deposition.

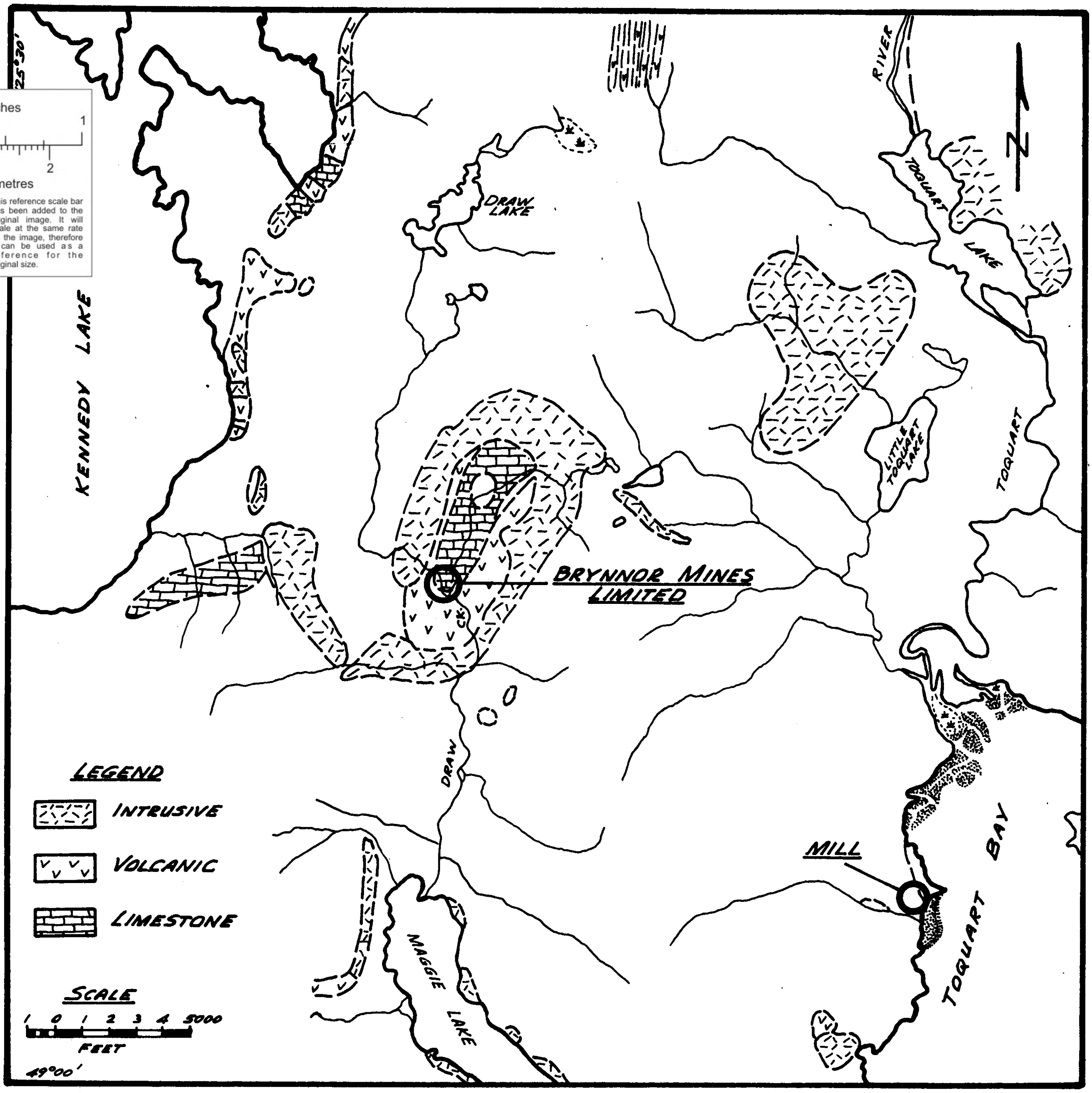
Ore

The Brynnor ore body is at the extreme southern end of the Triassic rock belt. The magnetite deposit is "L" shaped with the 1,500-foot north-south limb representing open pit ore and the 1,500-foot east-west limb the down faulted extension. The ore is largely a replacement within limestone drag folds along the tuff contact. Replacement of garnetized tuff has undoubtedly occurred but may not be extensive.

Ore within the pit area extends from above the 300-ft. elevation down to sea level. It occurrs within an overturned synclinal fold of limestone with its axial plane striking north and dipping flatly to the west.

Ore to the east of the pit dips steeply to the north. Strong drag folding of the limestone, which has resulted in repetitions of the ore structures to several hundred feet below sea level, has enhanced the ore potential of the Brynnor mine.





MINING

IMMEDIATELY following negotiation of the contract for the sale of concentrates, Kie Mines Limited, a subsidiary of Peter Kiewit and Sons (Canada) Limited, was engaged to carry out the required stripping and preliminary development of the orebody by open-pit methods. By the end of March, 1962, some 700,000 cubic yards of overburden and 2,300,000 cubic yards of rock had been stripped, exposing the orebody sufficiently for initial open-pit mining.

For present open-pit mining purposes, the Brynnor orebody may be simply described as having a saucer-like shape extending from a height of 300 ft. above sea level to minus 30 ft. Overall length of the pit ore is approximately 1500-1600 ft. and width varies up to 650 ft.

In the present early mining stages, a main 40-ft. berm is being established at the 300-ft. level for drainage, and additional berms are planned at regular safe intervals. Benches are 30 ft., with drilling to an average depth of 33 ft.

Drilling in the pit is done principally by a 40-R Diesel-powered Bucyrus Erie rotary, drilling 9-in. holes, and a Canadian Ingersoll-Rand Drill Master, drilling 6-in. holes, which is used in harder ground. Brynnor has extended the mast on the 9-in. drill so that a bench (up to 35 ft.) can be drilled in one pass.

Two track-mounted drills with individual compressors are used for

The Brynnor open-pit mine.

PHOTO, COURTESY CUMMINS DIESEL SALES OF B.C. LTD.

wall control. Excellent results have been obtained to date from the two large production drills, which are adequately taking care of both pit development and ore production.

An important factor in the decision to use large holes in the Brynnor pit was obtained from a study of explosive efficiencies. Tests were made using prilled ammonium nitrate in bags, with burlap sacking within a polyethylene liner. Results obtained indicated that the benefits from using prills in this fashion justified the larger holes.

At present a blasting pattern of 20 ft. by 18 ft. is used with the 9-in. holes and a pattern of 12 ft. by 14 ft. with the 6-in. holes. Hydramex is used for bottom loading with combinations of decking for top loading. To date both breaking and fragmentation experience have been very good. Almost no secondary breaking is required and shovels are not hampered by oversize.

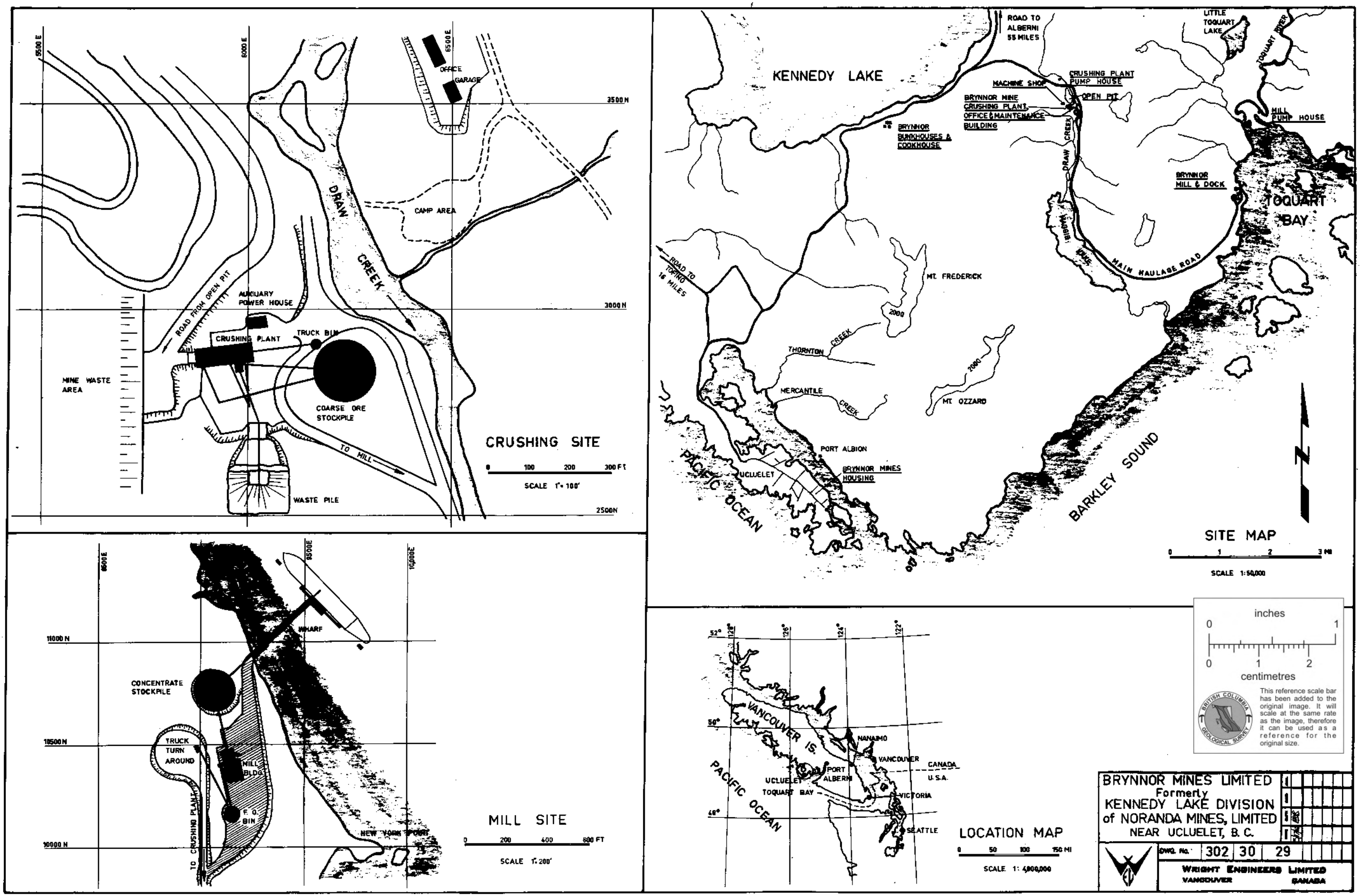
Loading in the pit is done by two Dominion 600 shovels with 2½-yd. and 3½-yd. buckets. The 2½-yd. buckets are used for ore and the 3½-yd. buckets for waste. An 88B Bucyrus Erie 4½-yd. shovel is used for waste removal.

Pit haul is handled by eight 32S Kenworth-Dart trucks of 21 yards struck capacity (approximately 35 tons) powered by 350 h.p. Cummins Diesels. Ore from the open-pit is trucked approximately 3000 ft. to the crushing plant where it is reduced to ⅝-in. size in three stages of crushing. (See following description of crushing plant and concentrator.) An estimated 4100 tons per day is hauled to the primary crusher from the present 240-ft. production level. Entry to the pit is by spiral road on an eight per cent grade, with haul distance extending as the main road spirals into the pit.

Nine-inch holes are drilled in the open-pit by mobile rotary Diesel-powered rigs.

The Ucluelet area on the west coast of Vancouver Island normally experiences heavy precipitation, particularly during the winter months. The probability of excess water accumulation in the pit has received consideration from Brynnor management. Plans call for establishment of several sumps with adequate pumping capacity installed on floats, sufficient to cope with any problem of excess water.

While only limited experience has been possible in the short production period to date, it is readily evident from inspection of the Brynnor pit that planning, mining methods and equipment are of the highest calibre. It seems reasonable to forecast that production and costs will be established at entirely satisfactory levels in keeping with the high standards of other Noranda operations.


CRUSHING SITE
SCALE 1" = 100'
0 100 200 300 FT
5500 E
6000 E
6500 E
3500 N
3000 N
2500 N
OFFICE
GARAGE
CAMP AREA
DRAW CREEK
ROAD FROM OPEN PIT
AUXILIARY POWER HOUSE
CRUSHING PLANT
TRUCK BIN
MINE WASTE AREA
COARSE ORE STOCKPILE
TO MILL
WASTE PILE
MILL SITE
SCALE 1" = 200'
0 200 400 600 FT
9500 E
10,000 E
11000 N
10500 N
10000 N
WHARF
CONCENTRATE STOCKPILE
TRUCK TURN AROUND
MILL BLDG.
F. O. BIN
TO CRUSHING PLANT
NEW YORK POINT
SITE MAP
SCALE 1:50,000
0 1 2 3 MI
ROAD TO ALBERNI 55 MILES
LITTLE TOQUART LAKE
TOQUART RIVER
KENNEDY LAKE
MACHINE SHOP
CRUSHING PLANT PUMP HOUSE
OPEN PIT
BRYNNOR MINE CRUSHING PLANT OFFICE & MAINTENANCE BUILDING
BRYNNOR BUNKHOUSES & COOKHOUSE
MILL PUMP HOUSE
BRYNNOR MILL & DOCK
TOQUART BAY
MAIN HAULAGE ROAD
ROAD TO TOFINO 16 MILES
MT. FREDERICK
THORNTON CREEK
MERCANTILE CREEK
MT. OZZARD
PORT ALBION
UCLUELET
BRYNNOR MINES HOUSING
PACIFIC OCEAN
BARKLEY SOUND
LOCATION MAP
SCALE 1: 4,000,000
0 50 100 150 MI
VANCOUVER IS.
NANAIMO
VANCOUVER
CANADA
U.S.A.
PORT ALBERNI
UCLUELET
TOQUART BAY
VICTORIA
SEATTLE
PACIFIC OCEAN
inches
centimetres
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.
BRITISH COLUMBIA GEOLOGICAL SURVEY
BRYNNOR MINES LIMITED
Formerly
KENNEDY LAKE DIVISION
of NORANDA MINES, LIMITED
NEAR UCLUELET, B. C.
DWG. No. 302 30 29
WRIGHT ENGINEERS LIMITED
VANCOUVER CANADA

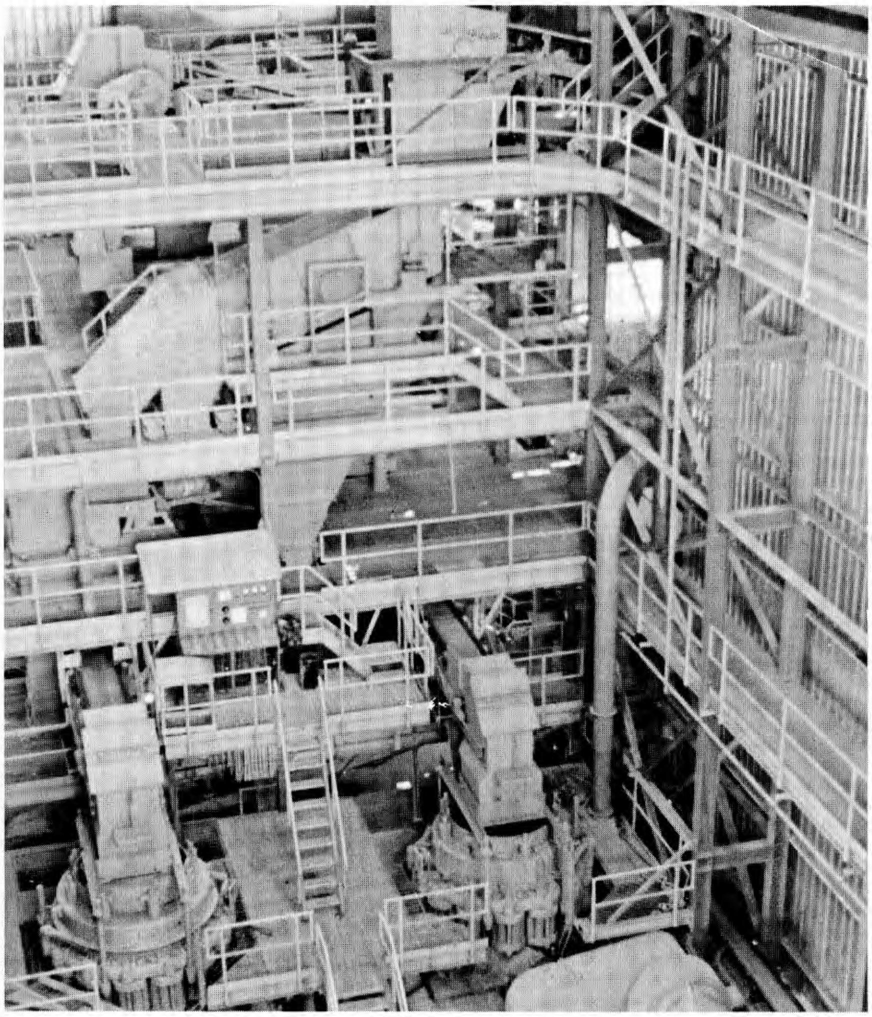
CRUSHING AND CONCENTRATING

THE production plant of Brynnor Mines Limited consists of two basic sections. First, a crushing plant with coarse waste cobbing contiguous to the open pit mine. Secondly, a concentrator discharging concentrate to stockpile alongside the deepsea shipping dock. The two sections are seven (7) miles apart and connected by a haulage road.

Crushing and Cobbing Plant

This plant was designed to receive ore at the primary crusher directly from the open pit trucks at a rate of about 800 tons per hour and to produce a minus ⅝-in. product after efficient waste removal by cobbing. The plant is designed on the premise that the orebody is clean and high grade at about 52% iron but will be contaminated primarily by wall rock and inclusions of waste material which are largely free of iron. Accordingly, the waste rock can best be removed at a coarse size and, in fact, crushing prior to waste removal will produce additional waste fines which cannot be as efficiently or as economically removed.

Trucks of 35-ton capacity, directed by signal lights at the control of the crusher operator, dump directly to the Canadian Allis-Chalmers 42-in. gyratory crusher operated at a 4½-in. open side discharge-setting. The crusher reduces each truck load at a rate on the order of 1,000 tons per hour and discharges to a 50-ton surge hopper.



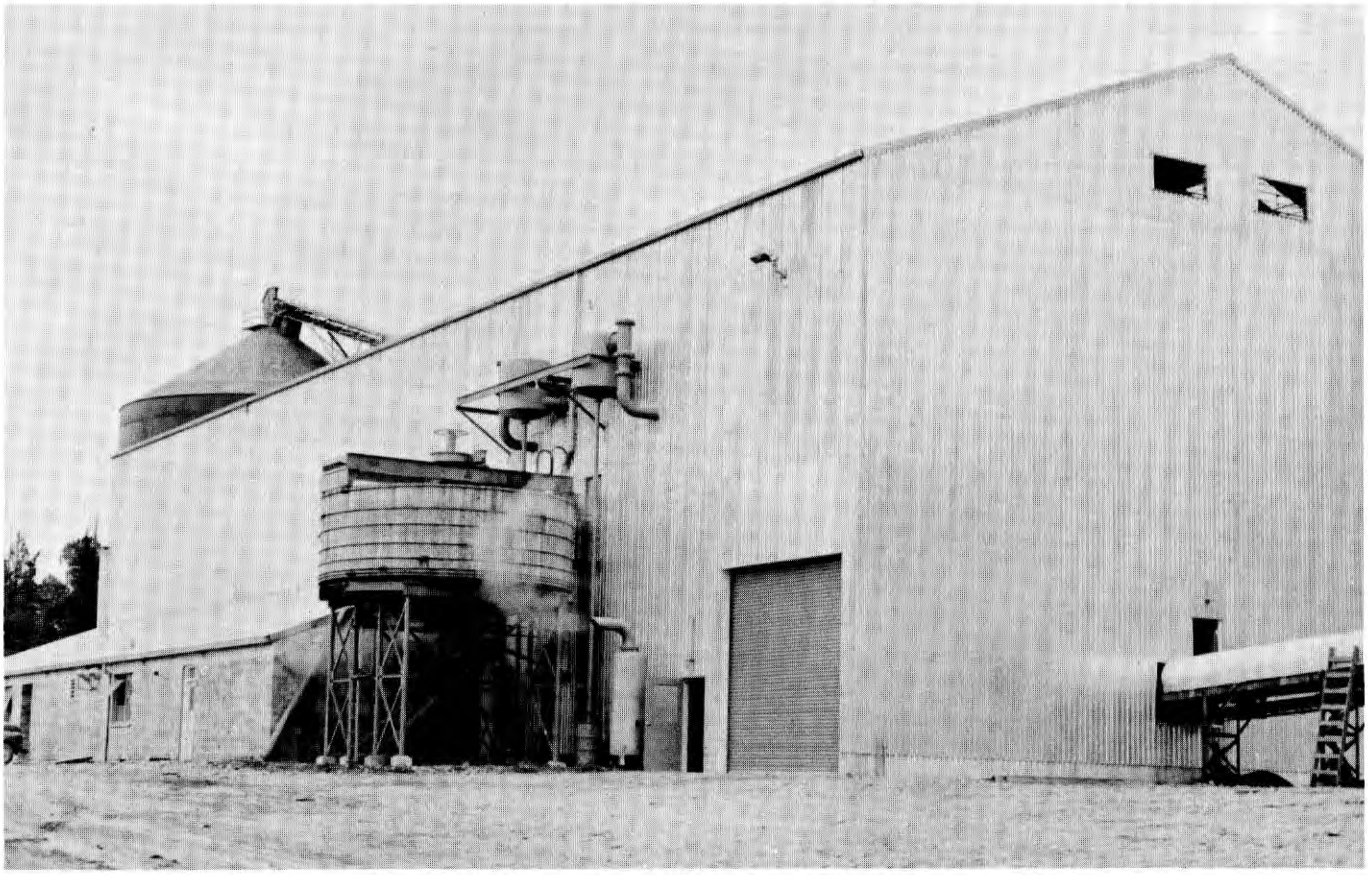
Interior view of the crushing plant showing control panel and secondary and tertiary crushing units.

From this hopper the feed rate is controlled by a 42-in. Model F86 Syntron vibrating feeder and ore is conveyed to the conical 3,000-ton coarse ore stockpile. An "A" frame cover is provided to avoid trouble which would occur from high rainfall (300 inches per year) washing fines down into the withdrawal cones. The pile is reclaimed by two 48-in. Model F55 Syntron feeders which are remotely controlled from the operating control centre located between the secondary and tertiary crushers. The feeders discharge to a 30-in. conveyor equipped with a Merrick Type "E" weightometer. The weightometer signal is transmitted to the control centre where a tonnage indicator, recorder and counter are located. The operator controls the feed rate at approximately 450 tons per hour to the primary 5 ft. x 12 ft. double-deck Ripl-Flo screen which removes the minus ⅝-in. fine as mill feed. The plus 2-in. material is cobbed on a Stearns electro-magnetic pulley of maximum strength to retain all magnetic material. The minus 2-in. plus ⅝-in. material is spread by a 3 ft. x 8 ft. Model MC2 Link-Belt feeder to a Stearns permanent magnetic pulley. The waste rock from the two cobbers is recobbed on a 36-in. x 36-in. Stearns Electro-magnetic pulley to produce a final waste product at a rate of about 100 tons per hour and a recovered material which is returned to the coarse ore stockpile. Waste is conveyed on an extendable conveyor with portable stacker to an adjacent disposal area.

Ore from the two cobbers is crushed in a 5½-ft. standard Symons crusher followed by a 5½-ft. short-head Symons crusher in closed circuit with two 4 ft. x 10 ft. Symons rod deck screens at ⅝-in. spacing and then conveyed to the 600-ton live capacity truck bin.

The primary section of the plant from crusher to stockpile is controlled entirely from the control cabin at the truck dump elevation and adjacent to the primary crusher.

The balance of the plant is com-



Exterior view of concentrator building showing Denver thickener.

pletely operated from the control panel located between the Symons crushers. To make remote operation practical the conveyors at critical points are equipped with flood switches, misalignment switches and ammeters. Delayed sequence starting with horn signals and full electrical interlocking are employed.

Cobbed Ore Haulage

Five Canadian Kenworth 848S tandem tractor units with belly-dump Columbia tandem trailers are used to haul ore from the truck bin a distance of seven (7) miles to the mill site at Toquart Bay. The road has a maximum unfavourable grade of 5% and an overall favourable drop in elevation of 300 ft.

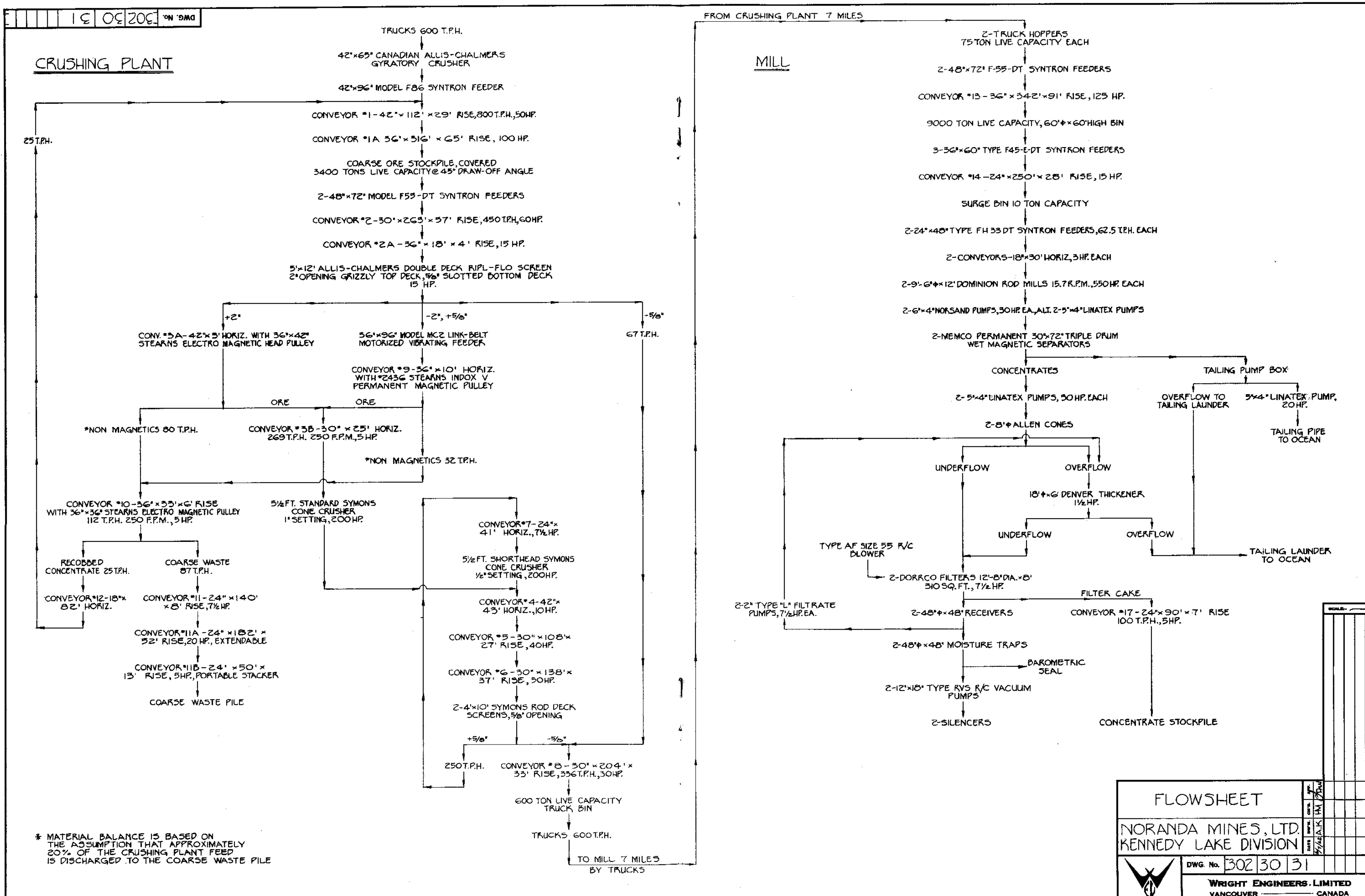
Truck drivers load their vehicles from the 600-ton bin in a matter of seconds through use of conveniently located valves which control two hydraulically-operated undercut arc gates. Trucks discharge to a 150-ton capacity grizzly-top hopper which they drive over. Ore is withdrawn from below by two 48-in. F55 Syntron vibrating feeders and is conveyed to a 60 ft. x 60 ft. high steel bin with conical roof. The flat bottom bin with reclaim tunnel under and three draw points has a gross capacity of 9,000 tons and a live capacity of about 5,000 tons.

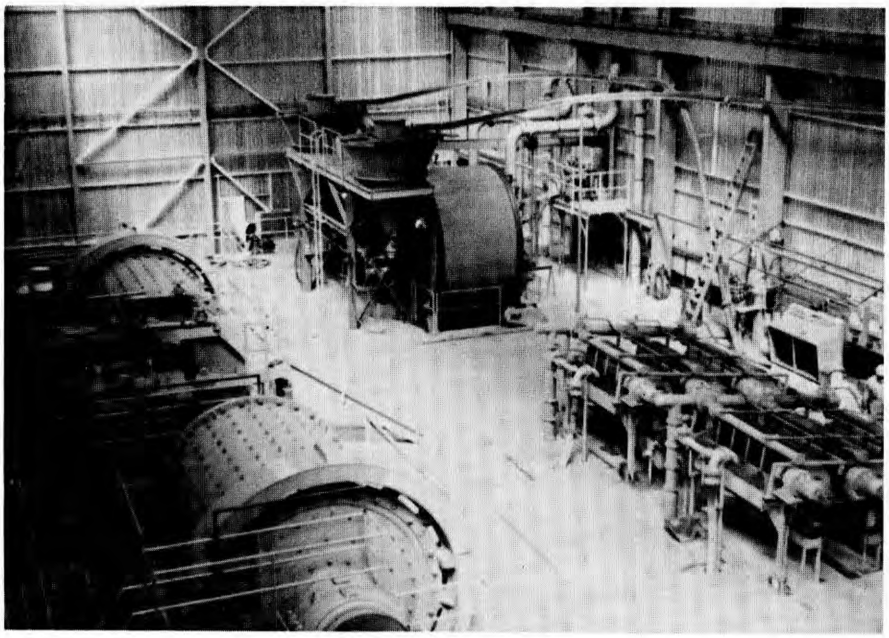
Mill

Because of the limited flat area at the mill site and the need for providing a large turn-around for the trucks without resorting to an unfavourable grade, it was found desirable to locate the fine-ore bin at a distance from the grinding section which made conventional separate feeders and conveyors to each of the two rod mills rather impractical. As a result, a 10-ton surge bin located adjacent to the rod mills receives ore from the fine-ore bin. This surge bin is mounted on a pivot and a load cell which provides a high and low level contact range. The high and low contacts operate the high and low feed rate settings on any of the three Syntron feeders under the fine-ore bin, thus maintaining the surge bin between approximately one-quarter and three-quarters full. In practice, any one of the three Syntron feeders (two normally operating) is set at a fixed rate well below minimum demand. Either of the remaining feeders is put on control with the high and low feed rate adjusted to be more than and less than the actual additional requirement. A high level alarm is provided in addition to prevent overfilling.

From the surge bin, the plant consists of two similar parallel and complete units. Each rod mill is fed by a Syntron feeder and a conveyor with a Merrick weightometer. The conveyor scale signal, through instrumentation provided by the Hagan Corporation, controls the Syntron feeder at a constant rate which is set by the operator. Ore is ground in two 9½ ft. x 12 ft. Dominion Engineering trunnion-overflow rod mills to produce maximum physical separation of magnetite and gangue within the limit of the product specification which calls for a fineness of about 35% minus 100 mesh.

The rod mills are operated in open circuit but with space allowed for either a mechanical classifier, wet cyclones, or a screen to close the circuit in future if it is found to be desirable. Each rod mill discharges through a trommel screen with ⅜-in. round opening to either a 4-in. Norsand or Linatex pump which pumps directly to the triple-drum, wet, permanent Memco magnetic separators.


DWG. No. 302 30 31
CRUSHING PLANT
TRUCKS 600 T.P.H.
42"×65" CANADIAN ALLIS-CHALMERS GYRATORY CRUSHER
42"×96" MODEL F86 SYNTRON FEEDER
CONVEYOR #1 - 42" × 112' × 29' RISE, 800 T.P.H., 50 HP.
25 T.P.H.
CONVEYOR #1A 36" × 316' × 65' RISE, 100 HP.
COARSE ORE STOCKPILE, COVERED 3400 TONS LIVE CAPACITY @ 45° DRAW-OFF ANGLE
2-48"×72" MODEL F55-DT SYNTRON FEEDERS
CONVEYOR #2 - 30" × 263' × 57' RISE, 450 T.P.H., 60 HP.
CONVEYOR #2A - 36" × 18' × 4' RISE, 15 HP.
5'×12' ALLIS-CHALMERS DOUBLE DECK RIPL-FLO SCREEN 2" OPENING GRIZZLY TOP DECK, 5/8" SLOTTED BOTTOM DECK 15 HP.
+2"
-2", +5/8"
-5/8"
67 T.P.H.
CONV. #3A - 42"×5' HORIZ. WITH 36"×42" STEARNS ELECTRO MAGNETIC HEAD PULLEY
36"×96" MODEL MC2 LINK-BELT MOTORIZED VIBRATING FEEDER
CONVEYOR #9 - 36" × 10' HORIZ. WITH #2436 STEARNS INDOX V PERMANENT MAGNETIC PULLEY
ORE
ORE
*NON MAGNETICS 80 T.P.H.
CONVEYOR #3B - 30" × 25' HORIZ. 269 T.P.H. 250 F.P.M., 5 HP.
*NON MAGNETICS 32 T.P.H.
CONVEYOR #10 - 36" × 33' × 6' RISE WITH 36"×36" STEARNS ELECTRO MAGNETIC PULLEY 112 T.P.H. 250 F.P.M., 5 HP.
5½ FT. STANDARD SYMONS CONE CRUSHER 1" SETTING, 200 HP.
CONVEYOR #7 - 24" × 41' HORIZ., 7½ HP.
5½ FT. SHORTHEAD SYMONS CONE CRUSHER ½" SETTING, 200 HP.
RECOBBED CONCENTRATE 25 T.P.H.
COARSE WASTE 87 T.P.H.
CONVEYOR #12 - 18" × 82' HORIZ.
CONVEYOR #11 - 24" × 140' × 8' RISE, 7½ HP.
CONVEYOR #4 - 42" × 43' HORIZ., 10 HP.
CONVEYOR #11A - 24" × 182' × 52' RISE, 20 HP., EXTENDABLE
CONVEYOR #5 - 30" × 108' × 27' RISE, 40 HP.
CONVEYOR #11B - 24" × 50' × 13' RISE, 5 HP., PORTABLE STACKER
CONVEYOR #6 - 30" × 138' × 37' RISE, 50 HP.
COARSE WASTE PILE
2-4'×10' SYMONS ROD DECK SCREENS, 5/8" OPENING
+5/8"
-5/8"
250 T.P.H.
CONVEYOR #8 - 30" × 204' × 33' RISE, 356 T.P.H., 30 HP.
600 TON LIVE CAPACITY TRUCK BIN
TRUCKS 600 T.P.H.
TO MILL 7 MILES BY TRUCKS
* MATERIAL BALANCE IS BASED ON THE ASSUMPTION THAT APPROXIMATELY 20% OF THE CRUSHING PLANT FEED IS DISCHARGED TO THE COARSE WASTE PILE
FROM CRUSHING PLANT 7 MILES
MILL
2-TRUCK HOPPERS 75 TON LIVE CAPACITY EACH
2-48"×72" F-55-DT SYNTRON FEEDERS
CONVEYOR #13 - 36" × 342' × 91' RISE, 125 HP.
9000 TON LIVE CAPACITY, 60'φ × 60' HIGH BIN
3-36"×60" TYPE F45-E-DT SYNTRON FEEDERS
CONVEYOR #14 - 24" × 250' × 28' RISE, 15 HP.
SURGE BIN 10 TON CAPACITY
2-24"×48" TYPE FH 33 DT SYNTRON FEEDERS, 62.5 T.P.H. EACH
2-CONVEYORS-18"×30' HORIZ, 3 HP. EACH
2-9'-6"φ×12' DOMINION ROD MILLS 15.7 R.P.M., 550 HP. EACH
2-6"×4" NORSAND PUMPS, 30 HP. EA., ALT. 2-5"×4" LINATEX PUMPS
2-MEMCO PERMANENT 30"×72" TRIPLE DRUM WET MAGNETIC SEPARATORS
CONCENTRATES
TAILING PUMP BOX
2-5"×4" LINATEX PUMPS, 30 HP. EACH
OVERFLOW TO TAILING LAUNDER
5"×4" LINATEX PUMP, 20 HP.
TAILING PIPE TO OCEAN
2-8'φ ALLEN CONES
UNDERFLOW
OVERFLOW
18'φ×6' DENVER THICKENER 1½ HP.
UNDERFLOW
OVERFLOW
TAILING LAUNDER TO OCEAN
TYPE AF SIZE 55 R/C BLOWER
2-DORRCO FILTERS 12'-8" DIA. × 8' 310 SQ. FT., 7½ HP.
FILTER CAKE
2-2" TYPE "L" FILTRATE PUMPS, 7½ HP. EA.
2-48"φ×48" RECEIVERS
CONVEYOR #17 - 24" × 90' × 7' RISE 100 T.P.H., 5 HP.
2-48"φ×48" MOISTURE TRAPS
BAROMETRIC SEAL
2-12"×18" TYPE RVS R/C VACUUM PUMPS
2-SILENCERS
CONCENTRATE STOCKPILE
FLOWSHEET
NORANDA MINES, LTD. KENNEDY LAKE DIVISION
DWG. No. 302 30 31
WRIGHT ENGINEERS, LIMITED
VANCOUVER CANADA



Interior of concentrator building, showing Dominion Engineering rod mills, Allen-type settling cones, and Dorrco filters.

On each of the three stages of magnetic separation the feed is diluted to about 30% solids with fresh water. The magnetic product from each drum is about 75% solids.

The product from the third drum of each separator at about 63% Fe is pumped by two 4-in. Linatex pumps to an 8 ft. dia. Allen-type settling cone with a 3-in. hydraulically controlled Clarkson valve controlling the underflow gravity which is maintained at about 75% solids for filter feed. The primary purpose of the settling cone is to deslime the filter feed; water can be added to the cone as required to facilitate the overflow of this slime. To avoid iron losses from the settling cone overflows, the dilute material is discharged to an 18-ft. diameter Denver thickener with underflow returning to the filters and overflow to final tailing. This slime removal is important for good filtration and the resulting loss of iron is negligible.

The 12 ft. 0 in. x 8 ft. 0 in. inside-drum Dorrco filters have a feed distribution launder to spread the feed over the 8-ft. width at the bottom and a gravity chute to carry the top discharged product to a conveyor. The 12-in. x 18-in. RVC vacuum pumps with 150 H.P. motors provide the design vacuum requirement of 5 c.f.m. per square foot.

Concentrate from the filters at about 5% moisture is conveyed to a covered 100,000 ton stockpile followed by ship-loading facilities.

Tailing from the first two magnetite separator drums contains nearly all the non-magnetic waste particularly the coarse material. This discharges to a 4-in. Linatex pump which is pumped outside the plant to the section where the tailing launder grade runs at a slope of 5%. Tailing from the third-stage drums and overflow from the tailing thickener are laundered to waste. The combined tailing discharges on the beach in the next adjacent bay.

Water Supply

The mill requires approximately 3,000 gallons per minute and this is obtained about 800 yards upstream at the Toquart River just above the tidal zone to avoid salt contamination. Because the Toquart is a prime Steelhead salmon stream great care was taken in locating the pumphouse and in the design of the intake, the size of the screens, and the attitude of the intake to the sweep of the river. The British Columbia Department of Fisheries was fully consulted.

Three Worthington three-stage vertical turbine pumps with 75 H.P. motors provide approximately 3,000 gallons per minute via a 16-in. steel pipe line which crosses under the Toquart River and discharges to the 30,000 gallon storage tank at the mill to provide a 90-ft. head of water. The 16-in. pipe is approximately 9,000 ft. long and of all-welded construction with butt strap joints. The pipeline follows the short line for part of the distance and, to avoid rock work, was buried in the tidal zone.

Acknowledgment

The portion of the project comprising Crushing Plant, Concentrator, Water Supply, Office, Warehouse, Maintenance Building and Camp Buildings were engineered and the construction supervised by Wright Engineers Limited. Flowsheet design and metallurgical decision and equipment selection were made by Mr. H. L. Ames and full liaison was maintained at all times between Noranda personnel and Wright Engineers Limited in order to coordinate and take full advantage of Noranda's experience. Construction was by John Laing & Son (Canada) Limited and their secondary company, Forward Installations Limited.

Metallurgical test work was carried out by Lakefield Research, Ontario Research Foundation, and by Noranda Mines, Limited.

M. A. Thomas & Associates Ltd. were electrical consultants on the project and Martin Dayton, P.Eng., was consulted on the Water Supply System.

Summary of Design Basis (Short Tons)

Primary Crusher	800 TPH to stockpile	5,400 TPD — 5 day week
Secondary Crusher and Cobbing	450 TPH feed	5,400 TPD — 5 day week
	350 TPH to truck bin	4,200 TPD — 5 day week
	100 TPH to waste	1,200 TPD
Mill Feed	3,000 Tons per 24 Hours	— 7 day week
Mill Product	2,400 TPD at 63% Fe, 35% minus 100 mesh, 5% H_2O	
Mill Tailing	600 TPD at 5% solids	

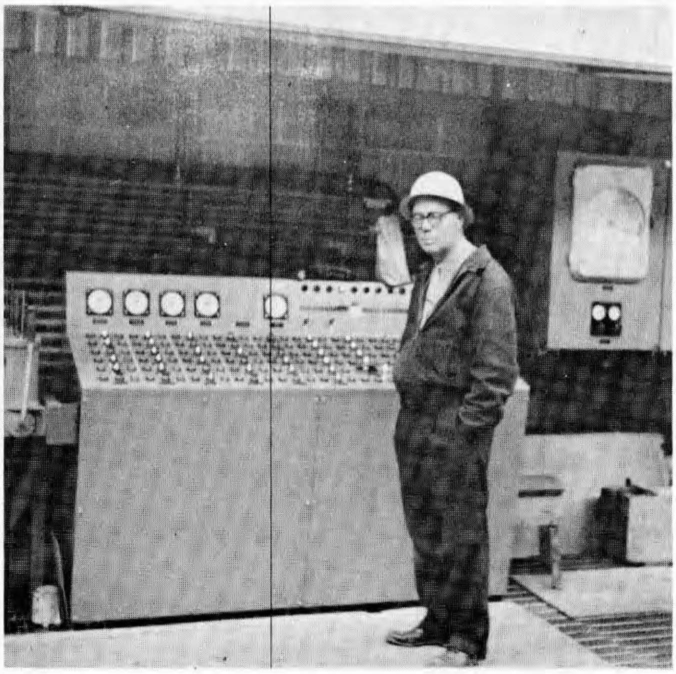
PERSONNEL

A CREW of approximately 125 men will be required for normal mining and milling operations. Staff personnel include: T. R. Wearing, manager; A. W. Haggerty, mill superintendent; D. W. Burns, pit superintendent; J. J. Bellefontaine, master mechanic; Walter Nelson, geologist; L. Gilbert, chief accountant; Ian MacDonald, storekeeper.

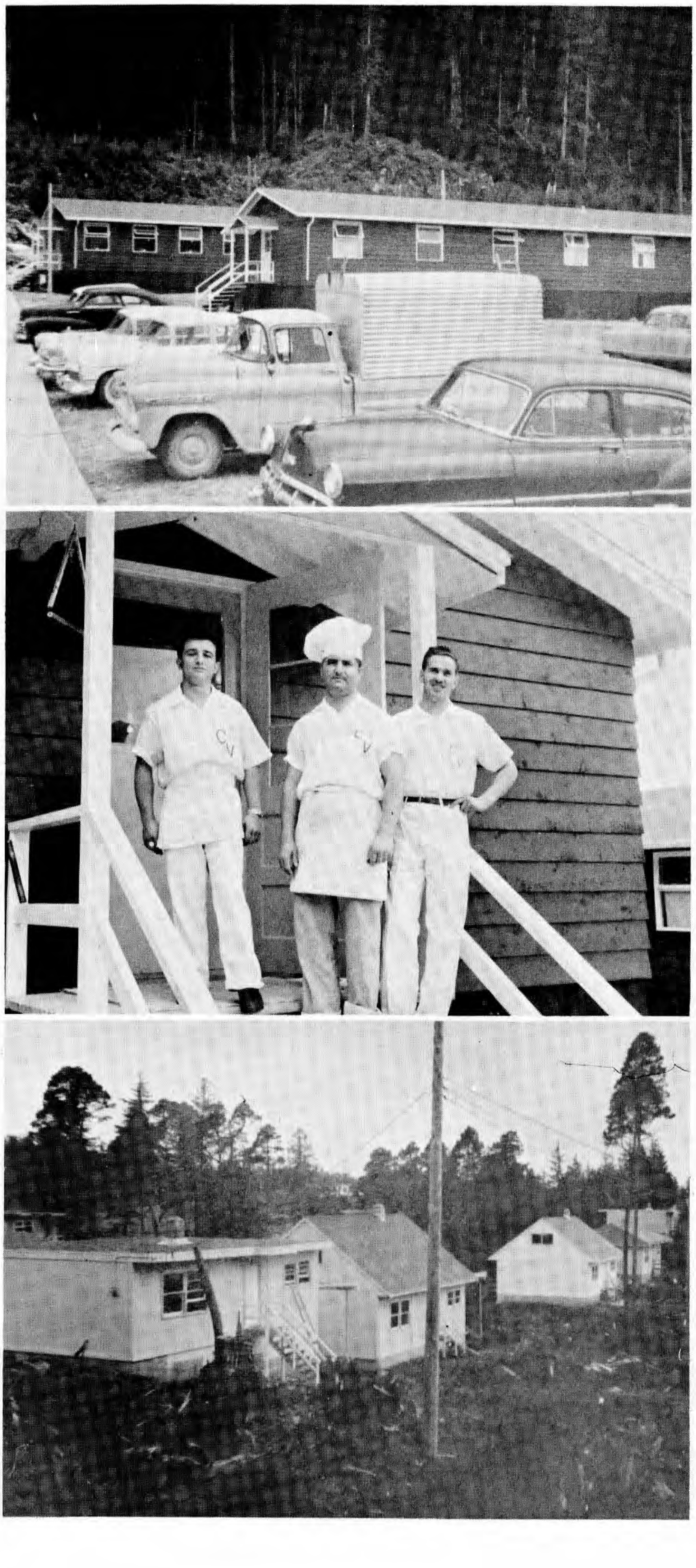
UTILITIES AND HOUSING

ELECTRIC power for all requirements is supplied by the British Columbia Power Commission (now the B.C. Hydro and Power Authority). The Power Commission showed commendable interest and efficiency in speeding construction of a 50-mile transmission line over very rough terrain from Alberni to Ucluelet. The new 66,000 volt line serves the Brynnor operation and the communities of Ucluelet and Tofino.

Construction is well advanced at Ucluelet on 22 housing units for accommodation of married personnel. Sentinel Construction Co. Ltd. contracted design and construction of most of the housing, which is located in an attractive new subdivision. Because of logging opera-



Great credit is due the members of the staff of Noranda Mines, Limited and Brynnor Mines Limited for bringing the Vancouver Island property from virgin forest to producing mine in less than two years. Some of those responsible for this achievement are shown on this page. Upper left: T. R. Wearing, manager; upper right: A. W. Haggerty, mill superintendent; lower left: D. W. Burns, pit superintendent; and lower right: H. L. Ames, chief metallurgist, Noranda Mines, Limited.



tions in the vicinity it was not possible to establish a residential community at the mine. Also it was considered desirable to take advantage of the benefits and facilities of the existing village at Ucluelet.

Modern, well-equipped dormitory and cookhouse facilities at Kennedy Lake provide for single men who do not wish to reside in Ucluelet. This camp has accommodation for 120 men in dormitory and trailers.

ACKNOWLEDGMENTS

WESTERN MINER AND OIL REVIEW gratefully acknowledge the kind co-operation and assistance of the management and staff of Noranda Mines, Limited and the management and staff of Brynnor Mines Limited in the preparation of this article.

We are indebted to Mr. T. R. Wearing, Mr. D. W. Burns and Mr. A. W. Haggerty for much of the information provided. Special thanks are due to Mr. Morris Menzies of Noranda Exploration Company, Limited for the geological summary, and to Mr. H. L. Ames of Noranda Mines, Limited for much of the metallurgical information.

Thanks are extended to Mr. H. M. Wright, president, Mr. L. F. Wright, and the staff of Wright Engineers Limited who assisted materially in the preparation of this article and in providing many of the accompanying illustrations.

We are most appreciative, also, of the opportunity afforded us by Swan, Wooster Engineering Co., Ltd., to publish concurrently the article on "Iron Concentrate Shipment" by Mr. Vagn J. E. Jensen and Mr. John V. MacDonald.

Completely modern dormitory and cookhouse have been erected at Kennedy Lake to provide for single men as shown in the uppermost picture. Catering is done by Cal-Van Caterers Ltd., whose cook and waiters are shown in centre. Some of the 22 staff residences now being built by Sentinel Construction Co. Ltd. at Ucluelet are shown in the photo at the bottom. Good roads connect all sections of the operation to the City of Alberni and existing Vancouver Island highways.

CONCENTRATE STORAGE AND LOADING AT TOQUART BAY

By VAGN J. E. JENSEN, P.Eng., and
JOHN V. MacDONALD, P.Eng.

Introduction

ONE of the materials handling problems to be solved at the Kennedy Lake mining division of Noranda Mines, Limited (now Brynnor Mines Limited) involved the periodic reclaiming of iron concentrates from a large stockpile. These concentrates are produced at the company's Toquart Bay concentrator, on the west coast of Vancouver Island, and have to be loaded-out by belt conveyor to ocean-going carriers.

Noranda engaged as consultants Swan, Wooster Engineering of Vancouver, British Columbia and Portland, Oregon, to design the entire stockpiling and reclaiming system from mill to wharf. The Toquart Bay shiploading system went into operation in May of this year and should reclaim and load concentrate at rates up to 1200 tons per hour.

Special Problems

Among some of the problems complicating design were the following:

An annual average rainfall at the site in excess of 300 inches; the very large "live" storage volume required for economical reclaiming and loading of vessels up to 45,000 tons capacity; the high rate of loading specified for rapid "turn-around" time; the tidal, ballast and ship trimming variations which must be accommodated and which combine to cause a total hatch height variation of more than 40 feet and a range in beam width between 60 and 104 feet; and finally the very "sticky" nature of the product to be handled.

Concentrate - A "Sticky" Problem

Magnetite concentrates present a difficult materials-handling problem because of the tendency of particles to adhere to one another particularly where attempts are being made to reclaim "live" from stockpile. It is known, however, that the degree of moisture and the percentage of "fines" in such products are factors directly responsible for this adhesive tendency which prevents these materials from flowing freely. It followed that the Toquart Bay system should include a structure for keeping the material dry, and non-clogging equipment for its successful handling.

Stockpile

In order to keep the costs of handling as low as possible, a system that deposited the stockpile from a stacker conveyor in a fixed position was adopted at an early stage of the planning.

The material is reclaimed by a conveyor placed in a tunnel under the stockpile. Four hopper openings are provided in the tunnel roof for this purpose.

This system divides the stockpile into 2 parts (as is shown in Figure 1):

1. Live storage, being composed of concentrate, which can be reclaimed by gravity alone, (provided the material is reasonably dry).
2. Dead storage from which mechanical equipment such as bulldozers, is required to bring the

Loading the "Yawatasan Maru" at Toquart Bay. Steel for the conical cover of the live concentrate stockpile was provided along with several other major construction units by the Western Bridge Division of Canada Iron Foundries Ltd.
PHOTO BY JAMES W. QUIN

concentrate within reach of the reclaim conveyor.

The live storage, which roughly comprises 35% of the entire stockpile, should be adequate for loading of ore carriers with a capacity of 46,000 long tons. Based on this requirement, it therefore was found that the entire stockpile should be about 100 feet high, since the angle of repose during deposit from the stacker conveyor would be close to 45°.

It was further decided that the dead storage stockpile would only be used in cases of emergency, since the cost of reclamation from this stockpile would be considerably higher than reclamation from the live storage stockpile.

Consequently, cover of the live storage portion of the stockpile was considered adequate, and no attempt was made to provide any cover for the dead storage.

Stockpile Cover

a) Preliminary Considerations

With these conditions, the structural problem resolved itself into providing a cone-shaped cover with a base 120 feet in diameter, with the top of the cone 110 feet above ground level and the base 50 feet above ground level. It would be necessary for the cover to support the end of the stacker conveyor, with the cover supports being outside the stockpile proper.

b) Description of Structure

Several schemes were considered, but in the design which was finally chosen 3 steel booms, each 180 feet long and 6 feet by 6 feet in section, form a giant tripod supporting 12 main cables secured to rock anchors or gravity anchors in the ground. These cables carry the cover material, a dodecagonal catwalk, which acts as a stiffening ring along the base of the cover, and a dodecagonal glue laminated stiffening ring, halfway between the base and the top. A hexagonal chamber suspended from the booms provides support for the stacker conveyor, and housing for some equipment. The glue laminated ring provides a base for a track upon which runs a motor-driven trolley which drags a chain around the rim of the stockpile to facilitate flow of the material to the reclaim conveyor.

The cover material chosen for the structure was corrugated sheet metal, nailed to timber purlins, spanning between the main cables. The purlins are supported by clip angles, attached to the wire ropes by wire rope clips.

The use of rigid timber purlins necessitated expansion joints at the supporting clip angles, otherwise increased sag, in the main cables, due to increased live loads, would produce undesirable compression forces in the purlin rings.

The final design provided a variation in the expansion gap from purlin ring to purlin ring, which should theoretically make all gaps close at the same time, allowing the purlins to absorb a controlled amount of compression, and at the same time limiting cable sag to a tolerable maximum value.

The corrugated sheet metal pieces flashing the ridges above the cables are bent in reversed V shapes, to allow for the expansion and contraction movement.

c) Design

In a suspension structure such as this cover, the stresses encountered will depend upon the sag which is allowed in the cables, with the stress decreasing as the sag increases. Resonance frequencies within the structure must be kept higher than those introduced by high winds, and it was therefore necessary that 10 tons of prestressing be applied to each cable. Prestressing the cables also served to keep forces within the structure reasonably constant, since increased stresses due to increased live loads usually result in decreased stresses due to elastic deformations.

The previously mentioned stiffening rings (catwalk and glue laminated ring) also serve as compression rings, in order to keep cable stresses and deflections within acceptable limits.

A structure of this type, can be analysed for evenly distributed loads with reasonable accuracy, but it was felt that information regarding wind loads, as supplied by various building codes, was far from adequate.

d) Wind-Tunnel Tests

It was therefore decided, to build a model of the structure in order to obtain information about the effect of windforces on it, by means of wind tunnel tests.

Professor G. V. Parkinson, P.Eng., of the University of B.C. was consulted, and guided by his expert advice and experience, a model of the structure in scale 1:90 was built.

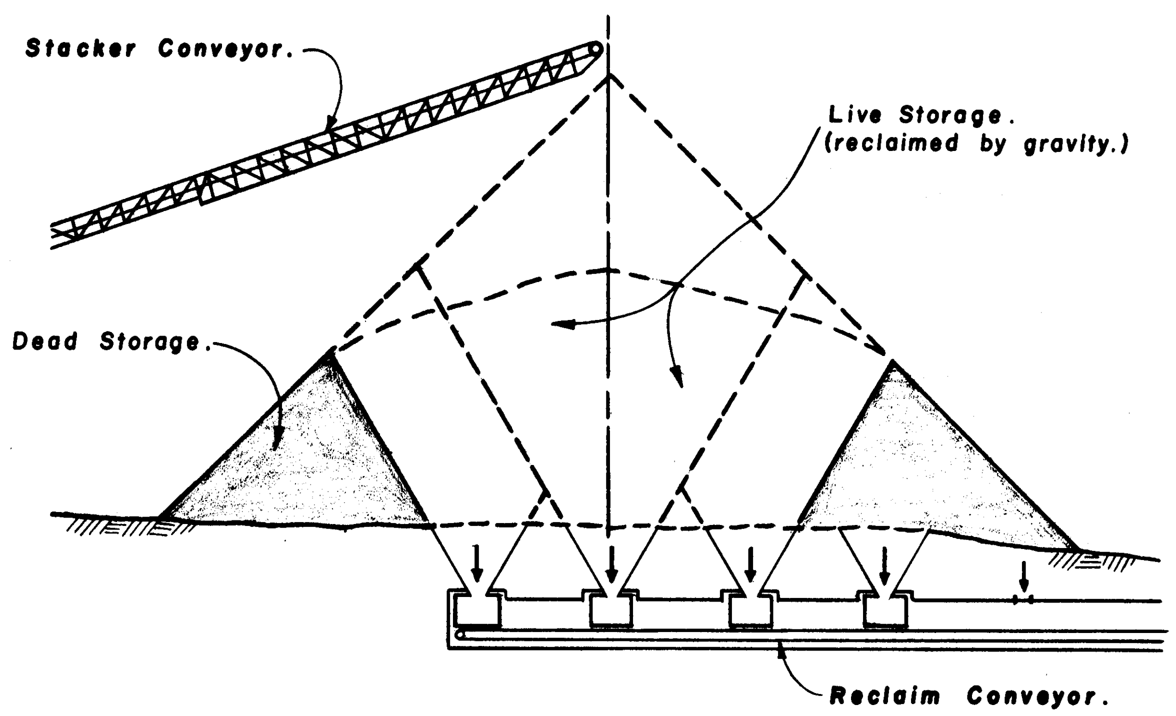
The greatest problem in building the model was to establish the pressure taps required to measure wind pressures on the inside as well as on the outside face of the cover. These taps had to be connected to instruments outside the wind tunnel; they had to present, however, only the minimum possible obstruction to the air flow, in order not to falsify the test results.

The problem was solved, by laminating the test panels on the model from two pieces of plexiglass, grooved on the contact faces from the evenly distributed tap holes, to the bottom edge of the test panel. Minute holes were then drilled, from the inside of the stockpile cone, (a hollow cardboard cone), through the plexiglass, into the grooves and hypodermic needles were inserted in them. The operation, requiring a tight fit, created a difficult problem for the model makers.

Due to the intricate fitting problems, one panel was equipped with 16 tap holes on the inside face, and another panel equipped with 16 tap holes on the outside face. The cover was then built to rotate independently of the supporting legs, so that readings could be obtained from the entire surface.

The model of the stockpile was also built in two parts, to simulate, 1) full size pile and 2) dead storage only, so that the effect of wind could be determined under these different conditions.

The test results showed, that the initial windload assumptions had been reasonably conservative. It was quite reassuring to find that the test showed that the pressure distribution around the structure followed the same pattern, which would be obtained from wind tunnel tests on cylinders, with slight modifications due to the cone shape.



SECTION THRU STOCK PILE.

e) Erection

A great deal of care and consideration went into the detailing of, both the supporting legs, and the cable and ring-girder assemblies, in order to reduce or eliminate as far as possible any erection problems.

The top assembly, where maximum forces of 600 tons will be transferred from the cables to the tripod legs, especially had to be as compact as possible. This assembly was made in such a way, that the cover could be hoisted into place as a unit after the tripod legs had been erected. The tripod legs being 180 feet long, were detailed in 5 sections to accommodate shipping by barge.

The main cables were prestressed after erection with a force of 10 tons, but even with this force, a fair amount of movement can be expected in a structure of this type.

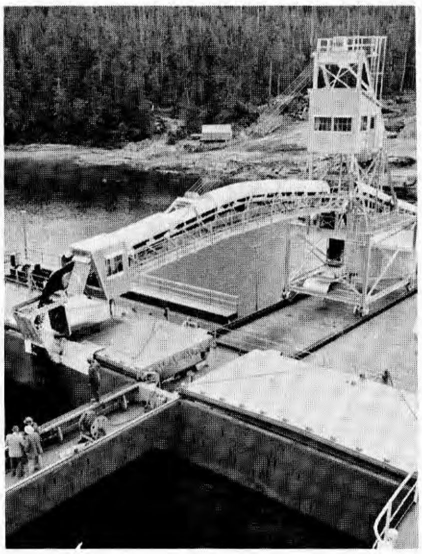
Connections were therefore detailed to accommodate horizontal movements, at the catwalk level, of up to 5 feet.

Loading From Stockpile

Investigation showed that with a tunnel some 10 feet below grade and with four feed points, the live storage could be increased over 100% to roughly 35,000 tons without an appreciable increase in overall storage. Equipment selected included air lances and agitating devices to help break "arches" and prevent "funnelling" as the material is drawn from within the stockpile. Special roll-type feeders were placed in the reclaim tunnel roof to control and direct this reclaiming flow. This anti-clogging roll feeder is of radically new design and can best be described in simple terms as being a pair of horizontally - mounted motorized rolls which rotate in opposite directions to allow a variable but controlled rate of material flow between them as their center to center distance is varied. The anti-clogging feature is due to the absence of any shearing forces being built up between the reclaiming material and the rotating rolls.

High Loading Rate

While vessels as small as 10,000 tons may load concentrate at Toquart Bay, the trend is expected to be to larger carriers. For this reason, an outloading rate of 1200 tons per hour was selected. This rate is considerably greater than the nominal 750 tons per hour capacity of many existing concentrate outloading installations on the West coast, but is more compatible with ships up to 45,000 tons, the maximum size of vessel expected to load at Toquart Bay. It should be pointed out that the instantaneous handling rate mentioned above is higher than the average handling rate. This is because a fixed type shiploader was selected with the result that the loading flow must be interrupted periodically to allow repositioning of the ship's hatches under the shiploader.



Loading iron concentrate aboard the Mitsui Line's "Yawatasan Maru". The vessel sailed May 31, 1962, with cargo of 26,400 wet tons.

The Shiploading Problem

Having dealt with the problems involved in placing a large flow of iron concentrate on a reclaiming conveyor in the most economical manner, the designers were faced with the final problem of placing the material within the ship's holds. Considering the variations in hatch height and ship beam mentioned earlier, the resulting analysis indicated the selection of a fixed type shiploader having a moving tower and boom loader. Such a shiploader consists essentially of a loading boom some 75' long which can be raised and lowered through some 25° to accommodate hatch elevation changes and which is supported from a mobile tower structure so that it can be moved across the beam of the ship during the loading operation, or retracted to be within the wharf face when ship shunting occurs or when the structure is parked. Additional trimming action during loading is provided by a pair of adjustable deflector plates placed at the end of the boom to steer the material flow in a desired direction. It is expected that one operator placed in a control cab at the end of the loading boom with finger-tip remote control of the shiploader motions will successfully meet the stipulated loading rate. This actually was demonstrated when the first ship was loaded recently.

Marine Structures At Toquart Bay

These structures include the four berthing dolphins, a wharfhead to serve as a berth for small coastal ships and barges, a single lane approach trestle to support the shiploader and reclaim conveyor, and two mooring buoys to assist in the moving of the ship during loading and for mooring in either of the extreme loading positions.

The berthing dolphins are of the energy absorbing type capable of resisting normal impacts of ships up to 45,000 tons deadweight capacity. The piles have been driven into sea bottom which had to be previously consolidated by gravel stabilizing fill to improve foundation characteristics.

The wharfhead and approach trestle are capable of supporting a 15 ton truck or a uniform load of 300 lbs. per square foot. Creosoted timber piles and caps have been used throughout along with Wolmanized timber stringers and deck planks.

The mooring buoys consist of anchor blocks of concrete connected by heavy stud-link chain to cylindrically shaped mooring floats of welded steel plate.

Acknowledgment

Contractors for the reclaim tunnel, stockpile cover and wharf respectively were John Laing & Son (Canada) Limited, D. J. Manning Construction Co. Limited and Pacific Piledriving Co. Limited. The Contractor for materials handling equipment was Barber - Greene (Canada) Limited.

The model was made by Lindsay Models and Metalcrafts Ltd. of Vancouver.

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