The Role of Truck, Rail and Ship Transport in the Development of Northwestern Canada

By CHARLES J. BROWN, P.Eng.

ABSTRACT

The discovery and development of mineral resources in North Western Canada, particularly the Yukon Territory, has been aided by a major road development program initiated by the federal government, and a modern integrated transportation system based on the container concept designed by the White Pass and Yukon Corporation Limited.

Recent mineral developments have led to a further upgrading of the principal transportation system and the establishment of a major deep-water port with related bulk loading facilities which will be among the largest of its type handling bace metal concentrates.

Yukon since 1960 has indicated that it is on the threshold of major changes both in regards to its economy and its distribution of population. Mineral resources are in the forefront of these changes. It has been said that no part of Canada has prospered until it has had good transportation facilities. This statement may partly explain why Yukon development has surged ahead relative to the Northwest Territories, certain areas of the Canadian Shield, and Newfoundland. Yukon not only has access to markets of the Pacific Basin through an ice-free port but also has access to continental Canada and United States over the Alaska Highway. There still remain large areas of Yukon yet to be developed. These areas will require additional transportation facilities which will in turn stimulate settlement and economic activity.

The Klondike Gold Rush first pointed to the need for Yukon transportation. In 1898 a railway was built between Skagway and Whitehorse, a distance of 110 miles to the head of navigation on the Yukon River. River boats were established to serve Dawson and other communities on the Yukon River and its tributaries. This system established the transportation pattern for years to come. The White Pass and Yukon Route survived the gradual depletion of the Klondike, the continual drop in Yukon population and the depression years. During this period the Carmacks coal field, the silver camp at Keno Hill, the Klondike gold fields and the needs of a declining population were serviced. The advent of World War II and the entry of United States into the conflict pointed to the defence needs of Alaska and the necessity of a continental link or road with the 48 states. The Alaska Highway was built through southern Yukon. Airports were established and roads built to service them. The Canol Pipeline was built from Norman Wells to Whitehorse and a service road built along its route. This new system of access resulted in a number of new mineral discoveries. United Keno Hill Mines entered into major production in 1948 and in 1951 an all-weather gravel road was constructed to service the camp. Truck transport then took over and the well-loved river boats were retired in 1955.

In 1958 an entirely new road program was embarked upon by the Canadian Government. This program is being continued and enlarged upon today. Since 1958 the Watson Lake development road, Nahinni Range Road, and Dempster Highway have been built. The Whitehorse Keno-Dawson Road has undergone major reconstruction. The Taylor Highway, Canol and Aishihik roads have been improved. The present government envisages a series of road loops arranged in such a manner that any resource project will not be more than 200 miles from a permanent road. These loops are proving popular with tourists and therefore will provide multiple use. Reconstruction of the Sixty-mile Highway and construction of an all-weather haulage road into Clinton Creek, the site of a major new asbestos mine, have recently been completed. Construction is under way on the Ross River-Carmacks road which will serve the new Ross River-Vangorda area, the site of a major new lead zinc mine.

The foregoing road program is the transportation pattern developing within Yukon.

Access to the outside world is supplied by the Alaska Highway to continental Canada and the United States, the Haines Highway, and by the White Pass & Yukon Route to Skagway and Vancouver. Communities and mining

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Born in England in 1925 and received primary education in Vancouver, B.C. Served with the R.C.A.F. and Overseas Merchant Navy. Graduated from U.B.C. in Geology in 1951. After Graduation was employed as a mine geologist at various mines, including United Keno in the Yukon. In 1955 joined the staff of Karl Springer organization and was engaged in exploration and mine evaluation. In 1960 was Chief Geologist at Canada Tungsten Mines Limited during their development. He joined the staff of the White Pass and Yukon Corporation in 1962 where he was employed in Property Evaluation, Resource Development, Engineering Management and Design work. He is at present Staff Engineer.

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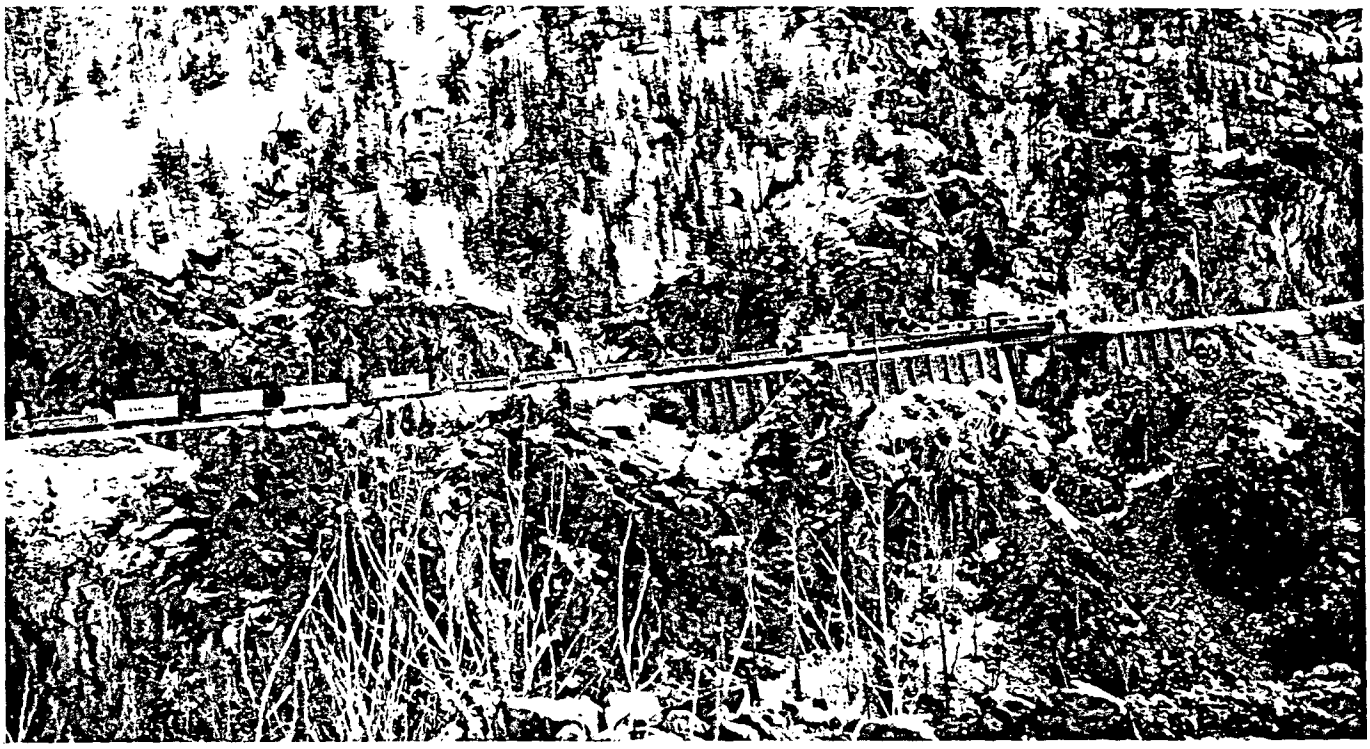


The route of the White Pass and Yukon railway passes through rugged terrain.

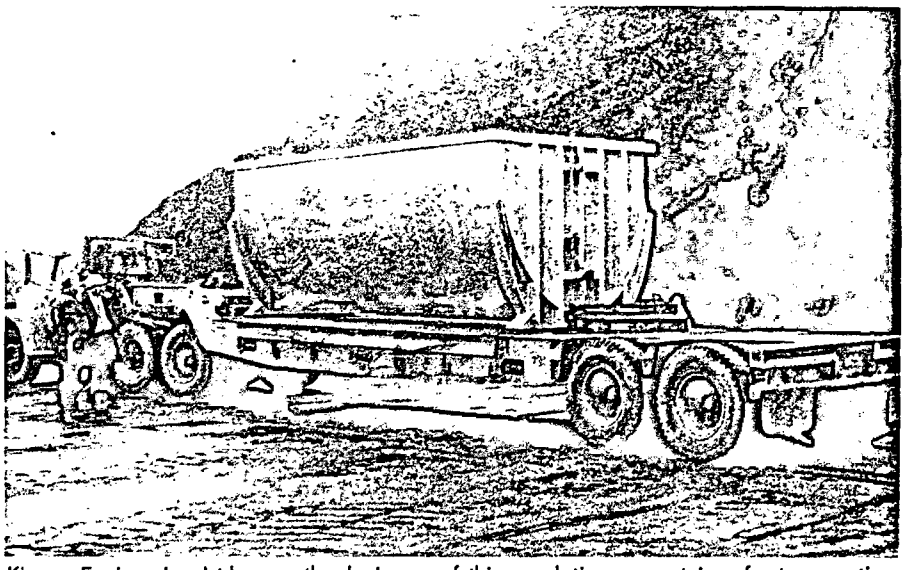
developments located along the Alaska Highway are supplied daily by truck transport with commodities originating in Whitehorse, Edmonton, and Vaucouver.

The average payload on the Alaska and Mayo Highway is in the order of 16 to 25 tons and is subject to government regulations. Highway haulage distances to railhead at Whitehorse vary as does the direction. The Clinton Creek asbestos development is located 395 road miles north-west of Whitehorse whereas the United Keno Hill operation is 287 miles to the north. Cassiar Asbestos is located in Northern British Columbia at a distance of 357 miles south-east of railhead at Whitehorse. In order to service these various mines multipurpose highway vehicles have been designed to allow maximum backhaul of petroleum products. The White Pass & Yukon Route maintains an integrated transportation system from Vancouver via ship, rail and truck to various Yukon points. This integrated transportation system was established in 1955 when it became apparent that three non-integrated systems (ship, rail and truck), with the various paper work and rising costs, could not continue to serve the needs of Yukon. Integration became the company policy and a system was developed. A special container ship (Clifford J. Rogers) was designed and built. This was the first specially built container ship in the world. The northern container integrated system was operational in 1955.

In 1965 over 8.5 million dollars were spent in upgrading the container facility and the constructing of a tanker-container ship designed specifically to serve Yukon and Northern B.C. This program was based largely on experience gained with the original container concept. A tanker-container ship, (Frank H. Brown) was constructed which is capable of handling up to 6,500 short tons of combined general freight and bulk petroleum products. Petroleum product capacity is approximately one million gallons. This ship

has been making 25 round trips a year year of 1700 nautical miles per trip. This year it has been put on an accelerated schedule. It is designed to handle 200 containers below deck and 60 above. The outside dimensions of the container are 25' 3" x 8' 8" and consist of vented, heated, dry and refrigerated units. Trays were designed to handle palletized concentrate and items not adaptable to containers. Racks were also built to handle freight longer than 25 feet. These units are handled by a ship's gantry crane at a rate of one unit every three minutes. Speed of unloading is governed by the ability to remove containers from dock area. Straddle carriers transfer the containers from one facility to another at Vancouver, Skagway and Whitehorse. Rail cars and flat deck trucks have been adapted to handle these units. Provisions have also been made to handle weights of up to 80,000 pounds. A sister ship to the Frank H. Brown is presently under construction and when combined with present operations this June will give Yukon and Northern B.C. weekly service. Yukon today is linked to the "Outside" by one of the world's most modern and efficient integrated transportation systems.

Anvil Mining Corporation announced late in 1966 the possibility of production from their massive lead-zinc deposit in the Vangorda-Ross River area.

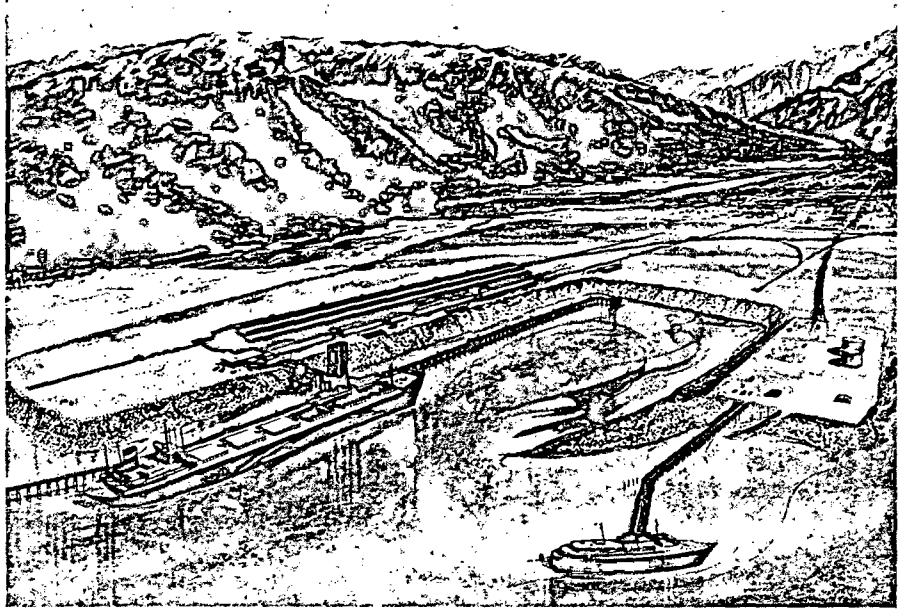


Kirwen Engineering Ltd. were the designers of this revolutionary container for transporting metal concentrates. The payload to tare weight ratio is more than twice that of other containers, a factor of great importance in its use by White Pass and Yukon Route in their highway and railway operations. The photograph shows the prototype undergoing a road test. Full-scale fatigue tests were also devised to simulate in the shop the severe and continuous rocking and twisting of the container throughout its life on trailer and rail car.

This deposit at that time had a drill-proven reserve in excess of 40 million tons of 10 per cent combined lead-zinc. This reserve has since been considerably enlarged. Production is scheduled to start in late August 1969 at the rate of 370 thousand tons of lead and zinc concentrate per year.

Anvil Mining Corporation Limited and the White Pass & Yukon Route jointly announced on December 4, 1967 that a contract had been signed covering the transportation of Anvil's lead and zinc concentrate to tidewater. This contract covered an initial operating period of eight years commencing in 1969.

The concentrates will be trans-



Artist's concept of Skagway terminal showing deepwater ship basin and related facilities.

ported 230 miles from the mine site to Whitehorse by truck and 110 miles from Whitehorse to the port of Skagway, Alaska by rail. At Skagway a harbour and bulk loading facility is being built by White Pass to load the concentrates into deep water ships for shipment to Japan.

Prior to the Anvil developments, White Pass & Yukon Route had conducted extensive feasibility studies for Skagway port facilities, upgrading the present railway, and its possible extension. These studies enabled an immediate start to be made on final engineering for the accommodation of Anvil shipments.

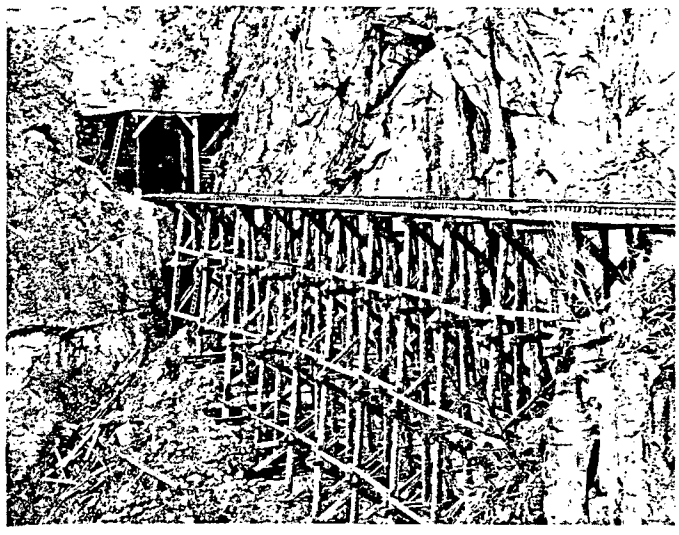
It was found that the port of Skagway could handle in excess of 10 million tons per year throughput of bulk shipments. A master plan for this possible throughput was designed for construction in stages when required, and is related to Yukon mineral development. The first stage will handle 500 thousand tons per year, the second up to 3 million tons and the third in excess of 10 million tons.

The first stage is presently under construction. A ship basin has been dredged in the tidelands at the head of Lynn Canal. This ship basin was excavated in fluvial sands and gravels deposited by the Skagway River. It has a useable dimension 350 feet wide, 1300 feet long and is dredged to a depth of 42.5 feet below mean low low water. The basin is oriented in a northeast southwest direction which parallels the prevailing winds.

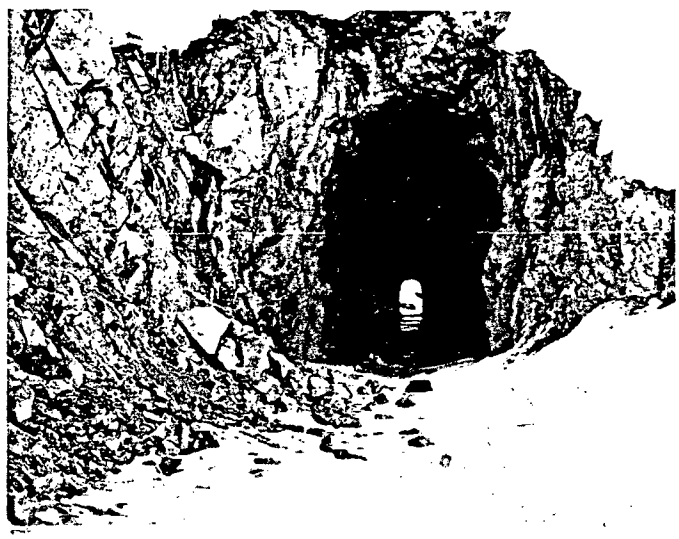
The dredged material was used to reclaim approximately 26 acres of tideland adjacent to the ship basin. There is additional acreage adjacent to the reclaimed lands that could be used if necessary. Approximately one million yards of sand and gravel were dredged to form this ship basin.

Construction is presently underway on a concentrate storage shed 720 feet long and 150 feet wide. Conveyor belts 48 inches wide will be fed through any two of five feeders by front end loaders. These conveyors will supply a fixed shiploader with a belt delivery capacity of 1500 tons of base metal concentrate per hour.

The concentrate shed will hold up to 100 thousand tons of concentrate and will be supplied by a travelling



Typical wood trestle. Tunnel driven in 1898.



A 700-ft. tunnel will help eliminate 215-ft. steel bridge

rotary gantry which will remove special containers from a unitized train adjacent to the shed. These containers will be transported to the nearest of five dumping bays and emptied. Concentrate will then be stacked and stored by front-end loaders.

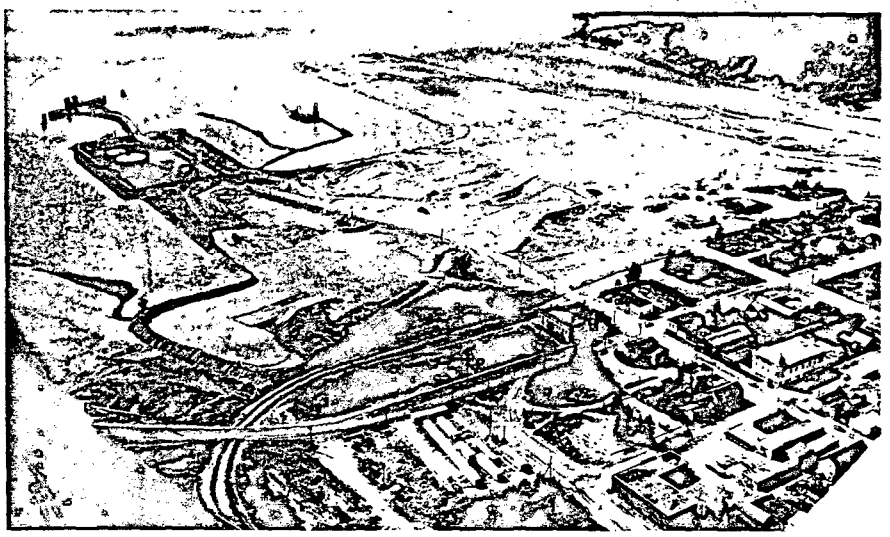
This bulk loading facility will be one of the largest of its type in the world handling base metal concentrate.

Simultaneous with port construction, a complete upgrading of the present railway is underway. The original roadbed and structures were built to a Coopers E27 rating and a 36 inch gauge. An analysis of present and future loadings coupled with a projected increase in train frequencies indicated a strengthening of the existing roadbed to a minimum Coopers E40 equivalent and that new structures and relocation work should be built to standard gauge specifications but with 36" gauge track. Trestles were strengthened and two additional stringers were added to the decks. Three trestles are being replaced with steel girder spans. A large 215 foot high steel bridge is being replaced by a smaller girder bridge and a 700 foot tunnel. All of the many concrete gravity retaining walls have been strengthened by the installation of vertical anchor beams at 10 foot intervals tied into solid rock by horizontal anchor rods. Some scaling and widening of the roadbed is also planned.

Two hundred new rail cars are on order. These cars will be equipped with the latest type braking system and roller bearings. The cars are specially equipped for use on up to 3.9 per cent grades and up to 20 degree curvature as existing on the present railway. Seven new diesel-electric locomotives are also on order. These locomotives will develop a useable 1200 horsepower and will have an operating weight of approximately 110 tons. Special attention has been given to the dynamic braking action of these locomotives. It is at present visualized that up to four locomotives will be used in tandem hauling a 1500-ton trailing load consisting of 35 cars each carrying a payload of 30 tons of concentrate.

The Federal Government has undertaken to upgrade existing gravel roads and new construction on the Anvil-Whitehorse truck route to handle 95 thousand pound gross vehicle weights. New tractor trailer equipment is being developed to handle the special concentrate containers. A complete study of trailer deflection caused by roadway irregularities has been completed. Special trailer arrangements are being devised so that mill supplies, packaged goods, coal, and petroleum products can be backhauled on the same unit used to haul outbound containerized bulk concentrates. Thirty-five tractor trucks and an equivalent number of semi-trailer units are on order.

The smallest but an important unit in this new transportation development is the container. The design criteria were severe, some of which were: ability to operate in temperatures ranging from 75 degrees below zero to 100 degrees above, to be waterproof, dustproof and contamination free, to be filled and emptied easily, and to be light in weight for highway haulage. Many shapes, sizes and profiles ranging through rectangular, circular and disposed vertically, circular and disposd horizontally as well as a number of variations of the truncated circle were investigated. The final shape chosen is approximately the shape of the bottom half of a tear drop in cross-section, because it is the shape that a free hanging membrane would naturally



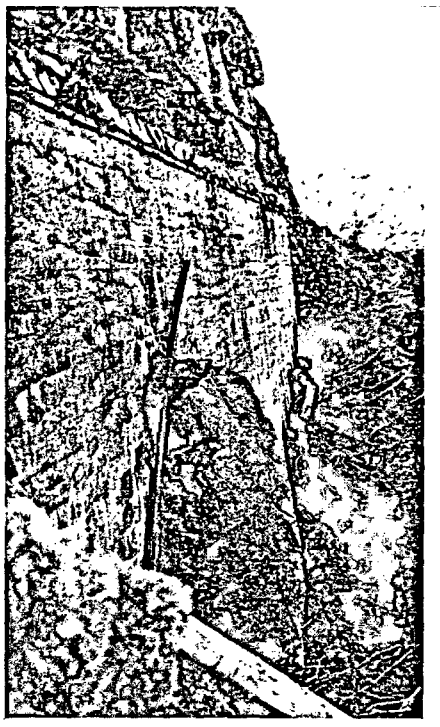
Dredging underway in Skagway ship basin

take under a suspended load. This shape was derived by experimentation and model construction.

Various materials were also considered ranging through steel, wood, aluminum, reinforced plastic, magnesium and nylon. All materials except two were rejected because of price, weight, durability, availability, maintenance or unsuitability in service; finally aluminum was chosen in preference to steel because of its weight and cold weather characteristics.

A prototype was built and subjected to a severe racking (twisting) test. At first considerable difficulty was encountered with fatigue failure at the corners where lateral and longitudinal extrusions met. This was finally overcome by increasing the radius of the corners and increasing the flexibility of the lateral extrusions. The prototype was then loaded and tested under expected highway conditions. Dumping tests were also carried out to test deflection of the underside longitudinal extrusion when under maximum load conditions. Final plans are now being drawn and some 200 of these containers will be ordered shortly. It is interesting to note that the container weighs approximately 2000 pounds and its lid 250 pounds and has a designed load capacity in excess of 30 tons of lead or zinc concentrate.

At Whitehorse the transfer of the container from truck to rail will be accomplished by a travelling overhead gantry. This gantry will straddle one rail siding and the road and be able to travel the full length of a train. The gantry will be rubber mounted.



Retaining wall ready for reinforcing by anchor rods and vertical bars

At Skagway a gantry will remove the containers from rail cars and rotary dump them after projecting them into the concentrate shed at their respective bays. This gantry will be rail mounted.

This primary transportation system presently under construction is designed to handle the immediate future requirements of Yukon. These facilities can be quickly expanded when called upon to handle the Yukon requirements of the foreseeable future including the development of the large iron deposits of the Snake River.

The effects of the road building program of the Federal and Territorial Governments, the presence of an efficient and modern primary transportation system, the increase in world metal markets (particularly around the Pacific Basin), devaluation of the Canadian dollar, and influx of foreign capital are evident in the high level of economic activity in Yukon today.

The foregoing has outlined what has and is taking place in Yukon in respect to transportation. The vision of greater developments for Yukon is closer to actuality than ever before. Discovery, development, and confirmation of mineral deposits, particularly since 1960, are very encouraging. New access roads and new methods of transportation will all play their part. A railway extending gradually north almost to the Arctic Ocean and branching out east and west will be of prime importance. This will not happen overnight. Time, hard work, much money wisely spent, much labour economically employed, and much careful planning by mining, government, and transportation interests will be necessary. These added facilities will ensure that Yukon will develop into a productive and self-sustaining entity making its full contribution to the growth of Canada.

ACKNOWLEDGEMENTS

The following engineering companies and individual engineers have contributed to the recent expansion program for handling bulk concentrates. It is to the credit of the Engineering Profession that these engineers have co-operated together and with White Pass & Yukon Corporation, in engineering unique facilities, for transporting and loading aboard ship, bulk concentrates in a far northern climate.

Tippetts-Abbett-McCarthy-Stratton, Seattle, Washington — Port facilities and Civil Engineering - Skagway.

Wright Engineers Ltd., Vancouver, B.C. — Concentrate handling machinery - Skagway.

Kirwen Engineering Ltd., Vancouver, B.C. — Bridges, trestles, container design and structural engineering.

McElhanney Surveying & Engineering Ltd., Vancouver, B.C. — Surveying, volumes, tunnel design and photogrammetry.

Golder, Brawner & Associates Ltd., Vancouver, B.C. — Retaining wall analysis soil mechanics.

Everet Weston, P.E., Chicago, Illinois — Rail car and locomotive specifications.