C. McCall

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TRANSPORT REQUIREMENTS FOR THE GROWTH OF NORTHWEST NORTH AMERICA

LETTER FROM THE CHAIRMAN, ALASKA INTERNATIONAL RAIL AND HIGHWAY COMMISSION, TRANSMITTING THE FINAL REPORT OF THE ALASKA INTERNATIONAL RAIL AND HIGHWAY COMMISSION, PURSUANT TO PUBLIC LAW 884, 84TH CONGRESS

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Research Report by Battelle Memorial Institute on an Integrated Transport System to Encourage Economic Development of Northwest North America

MAY 25, 1961.—Referred to the Committee on Interior and Insular Affairs and ordered to be printed with illustrations

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FOREWORD

The vast area of Northwest North America represents a major portion of the last pioneering frontier on the continent. Many of its resources are reasonably well known; but any attempt to inventory and appraise the Area's hidden mineral resources - certainly a major feature in its future economic potential - is a task involving decades of exploration and development work and hundreds of millions of dollars. Sizable though past exploration efforts have been, they have only scratched the surface in showing the magnitude of mineral developments that might take place in the future. Technologic advances of presently unknown magnitude and import will surely make significant contributions in facilitating discovery and development of these resources in the next 20 years.

Meaningful conclusions on transport needs for resource development should be based on objective analyses. Projections of mineral-resource developments in this study have therefore been made, in the main, from known occurrences. Magnitude and location of new discoveries simply cannot be predicted with any reasonable degree of probability. In spite of this uncertainty over future mineral potentials, economic growth of the Area from known resources in the next 20 years appears quite promising.

Again, the appraisal of improved transport facilities needed for resource development has been based primarily on known and proved transport methods. The inevitable march of technology will surely register major improvements in various types of transport - whether it be to greatly accelerate water transport by hydrofoils, to expand geographic accessibility by submarine freight and passenger service, to simplify and cheapen land transport by "air cushion" vehicles, or to improve and cheapen air transport by various methods.

These hidden resources and unknown but inevitable technologic advances are intangible assets whose imprints on the Area's future progress cannot now be timed or evaluated.

But perhaps the most potent intangible and immeasurable assets of the Area are the heart, the courage, and the will of its people. In every population there are always some who seek new country, new adventures, and new challenges in an environment where they are their own masters. Such people are willing to rely on their own personal resources for existence and to face the hardships and problems of the life they have chosen. Their motivations may be many - dislike of the crowd and pressures of conformity, love of the outdoors, escape, fortune, risk, or self-satisfaction in conquering the unknown. Such people pioneered in opening up the United States and Canada - through the 17th, 18th, and 19th centuries.

Problems of present-day Northwest North America are not strictly comparable to those of a century ago. There are possibly greater barriers to its economic development today than was then true of the prairie states and the West. But these barriers will not deter all of the pioneers in our present and future populations. The Area's unique frontier characteristics will serve as a magnet to those of true pioneering spirit.

As the population of the United States and Canada grows - probably doubling in the next half-century - economic pressures will force those who seek space and love nature to move toward the far Northwest. There they will find wild game, fish, and mountain grandeur unexcelled in the world. Armed with the products of inevitable technical advance, the vast and broad spectrum of the Area's resources will be found, developed, and put to use in the service of mankind.

Some way, somehow, these people will exist, they will multiply, they will be productive. And in the course of their progress they can find that satisfaction they seek in a dynamic, expanding Northwest North America that will evolve from their efforts.

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ERRATA

All maps of the entire Area in the report incorrectly show a road going to Whittier, Alaska; there is no such road. Also, they incorrectly show the location of Takla Landing, B.C. (identified east of Hazelton on Figures IV-1 and VII-1), which actually represents the location of Old Hogem, B.C. The road should proceed southwestward from this location to Takla Landing on the east shore of Takla Lake.

I. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Northwest North America, with its population of 364,000 scattered over an area of some 1,150,000 square miles, represents a vast, largely undeveloped frontier. Probably close to half of this limited population, which totals only as much as the city of Oakland, California, is heavily concentrated in three relatively small areas: Anchorage and Fairbanks, Alaska, and the Peace River region of British Columbia and Alberta.

With roughly half the area and two-thirds of the population of this entire area, Alaska's economy is based heavily on government expenditures – for both military and civilian purposes. Alaska's spectacular growth in the past decade has sprung mainly from this same source.

The economy of the Canadian parts of the Area is based largely on resource development – metals and minerals, oil and gas, forests, and agriculture.

With the probability that future military expenditures in the Area will not increase, and may even decrease, the Area's future economic growth will depend largely on development of industries based on local resources – tourism attractions, fuels, forests, metals and minerals, hydro power, fish, and agriculture. Lack of adequate transportation has been cited repeatedly as a major obstacle in developing the Area's resources.

This report appraises these resources – in terms of taking inventory of those known to be present in the Area and estimating their marketability in the next 20 years – points out transportation improvements needed for resource development, gives estimated costs of selected transport facilities, compares costs and benefits of such facilities, outlines methods and problems of financing construction of such transport facilities, all leading up to recommendations for specific transport improvements. Emphasis was placed on major transport facilities linking Alaska with the southern 48 states, with special consideration to those in the Pacific Northwest, and to major feeder routes tying to such major links. Specifically omitted from the Battelle study was any consideration of strategic military factors as justification for improved transport facilities in the Area. Also, population estimates take no account of possible changes in military and Government activities in the Area – principally Alaska. The only reasonable assumption that could be made from checks with defense officials was for continued activity at about 1959 levels.

Resources

Knowledge concerning the quantity and quality of resources in the Area varies greatly. Even though serious gaps exist, data on location, quantity, and quality of the Area's forests, fish, wildlife, hydro power, agricultural lands, and tourism attractions are reasonably well known. On the other hand, knowledge of the Area's potential for development of resources hidden beneath the surface – oil and gas, coal, and metals and minerals – is relatively poor. In spite of long and extensive search for gold and more recent exploration for other metals and minerals, the vast areas of potential mineral ground have only been scratched by modern prospecting techniques. Because of the extreme uncertainties in probabilities of finding hidden deposits of minerals and fuels of commercial size and grade in areas considered favorable geologically, however, appraisals of the Area's resources of these materials have been based mainly on what is now known to be present. As has been notably true in oil and gas in 1957-1960, major discoveries may change the picture almost overnight for these fuels, while a meaningful appraisal of a major find of metals or minerals may normally require several years for drilling and underground development before judgment can be made as to its importance.

Tourism. Tourism is an important economic activity in Northwest North America now, and it bids fair to become the most important of all contributors to the Area's economy by 1980. In order to assure a real growth in tourism it will be necessary to exert strenuous and constant efforts to this end from all angles, including the following:

(1) Schedule more tourist or coach rates on airlines serving the Area

(2) Continue to improve air schedules from the central and eastern parts of the southern 48 states

(3) Give greater attention and service to visitors' needs in respect to lodging, eating, and other travel services

(4) Develop a greater variety of tourist attractions and activities

(5) Build more and better accommodations at low rates both in the Area and on roads leading to it

(6) Reduce the distance and cost, and improve the comfort of auto travel to and in the Area

(7) Provide a variety of ways of traveling to the Area

(8) Extend the length of the tourist season, striving for nearly year-round activity

(9) Create and maintain effective promotional efforts.

Assuming that needed transportation facilities and tourist accommodations are provided and that vigorous, effective promotional efforts are launched and maintained, tourist expenditures in Northwest North America could soar from the present level of about $93 million to $472 million by 1980. In addition, a significant share of the additional expenditures, $123 million, would swell the Area's payrolls and lead to increased employment and population, 21,600, and 130,000, respectively.

Data used in arriving at such numbers as the preceding were the best available in an admittedly limited, vague, and frequently unreliable supply of statistical information. Although the process of developing reasonable or plausible projections to 1980 was largely based on intuitive judgments, the final result is considered to be conservative and attainable if the provisions for removing obstacles to future travel are made as indicated.

The most promising transport facilities that would contribute to development of tourism are: (1) an asphalt-surface-treated highway from Hazelton to Jakes Corner via

Atlin, using segments of the Stewart-Cassiar Road, (2) upgraded and asphalt-surface-treated Alaska Highway between Charlie Lake and the Yukon-Alaska boundary, (3) the Southeastern Alaska ferry connecting Prince Rupert with "Panhandle" cities and the Haines Cutoff leading to highways in Central Alaska, and (4) the Port Hardy-Kitimat-Stewart ferry. These major transport facilities would provide faster, more comfortable, and more economical travel routes for tourists than anything now available and would permit several alternative ways for a traveler to visit the Area without retracing his steps over long stretches of highway. Cut-throughs from Petersburg, Alaska, to the Stewart-Cassiar Road via the Stikine and Iskut Rivers, and from Route 5 to Juneau would provide alternative as well as attractive shorter circle routes for tourists who do not have time to go "all the way". In addition, these new routes would traverse large sections of beautiful scenery in the Area, as contrasted to portions of relatively uninteresting country along the Alaska Highway. These natural attractions include the awesome splendor of great snow-capped mountains, beautiful streams and valleys, glaciers and fiords, fish and game, and many others for the beauty or pleasure seeker, camper or hunter. It is estimated that the number of travelers from outside the Region visiting the Canadian area solely would be almost equal to the number passing through the Region with destinations in Alaska.

Oil and Gas. Northwest North America, containing a number of large sedimentary basins, is one of the few remaining areas in North America offering promise for discovery of new, large-scale deposits of oil and gas. The successful northwestward march of drilling activities from the petroliferous regions in Alberta and British Columbia appears to indicate great potentials in the sedimentary basins extending farther northwest and west in Yukon Territory and Alaska.

Value of output of oil in the Area in 1958 was about $15 million, virtually all from the Peace River area of Alberta. Value of gas output was about $8 million, all from the Peace River region, with about half each from northwestern Alberta and northern British Columbia.

Drilling activities on Kenai Peninsula of Alaska since 1957 have indicated a major-size gas field, a medium-size oil field, and promising gas and oil deposits, warranting construction of a gas pipeline to Anchorage and of an oil pipeline to Cook Inlet to allow shipments of crude oil to the U. S. West Coast. Promising shows have also been obtained from test wells near Yakutat and Yakataga along the coast east of Cordova.

Substantial oil and gas reserves were indicated in Naval Petroleum Reserve No. 4 along the Arctic slope by extensive exploration and drilling in the decade 1944-1953. Steps have been initiated leading to possible abolition of this Reserve with transfer of jurisdiction to the Department of the Interior. This is of course aimed at opening up this area to private development. Commercial oil production would require the discovery of appreciably more reserves than are presently known.

Total industry expenditures on oil and gas activities in Alaska are now totaling about $30 million annually, with about half spent on exploration and half on drilling and production. During 1960, six to eight drilling rigs operated in various possible petroleum provinces, and 22 geological field parties explored even more widely scattered promising petroliferous areas.

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Based largely on plausible projections of potentials presently known in the Kenai, it is estimated that by 1980 Alaska might well produce 25 million barrels of crude oil annually valued at $60 million based on 1960 prices in California less shipping costs, and 100 billion cubic feet of gas valued roughly at $15 million based on an estimated 1960 going rate for large-quantity consumption if it were obtainable. Additional major discoveries in other parts of Alaska – well within the realm of probability – could increase these figures many fold.

Oil and gas developments in the Canadian portions of the Area have centered around the Peace River region, and have taken place largely in the past 5 years.

For northwestern Alberta, the Royal Commission on the Development of northern Alberta estimated in 1958 that annual oil output would increase about tenfold between 1958 and 1980 to an annual production of 62 million barrels, and natural gas would increase almost fourfold to an annual total of 213 billion cu ft. These estimates are highly speculative as there is no way of knowing whether oil and gas will be found at the rate and average productivity per acre assumed; but in view of the continuing success in drilling activities in northwestern Alberta, there is good reason to believe that the estimates are conservative. Results obtained in the next decade will determine the scale of activity by 1980.

In northern British Columbia, oil production is lagging behind natural gas, and new drilling northward indicates even heavier emphasis on gas. Output of oil in 1959 was 866,000 barrels and of gas was 70 billion cu ft. Average value of oil at the well was $1.82 per barrel and gas was 6.5 cents per Mcf (1000 cu ft). Gas is piped southward along the general route of the P.G.E. Railway right-of-way to Vancouver and thence to the Pacific Northwest states. Based on plausible extensions of known oil and gas activities in northern British Columbia, annual oil output by 1980 is projected to 50 million barrels and natural gas to 464 billion cu ft.

Excess of supply over demand in the world oil picture is expected to be corrected in a few years by higher rates of demand increases, especially in foreign consuming areas. Markets for long-range increases in petroleum output from Northwest North America appear to be assured by the high and growing demand rate in the Pacific Coast areas of the U. S. and Canada, with U. S. West Coast indigenous supplies probably pegged at no more than current rates. Annual demand for oil products in U. S. West Coast states is projected some 400 million barrels higher in 1980 than at present – a level that should provide ample markets for expansion of petroleum output from Alaska and Canadian parts of Northwest North America well beyond the 130 million barrel increase projected in this report. Growing needs in Japan, Hawaii, and Alaska would supplement what appears to be more than adequate long-range outlets on the American West Coast.

Markets for gas supplies developed in British Columbia, Alberta, and adjacent parts of Yukon and Northwest Territories are certainly assured to the south by the growing markets in Canada and the U. S. West Coast, via pipeline transmission. It is doubtful if pipelines to these consuming areas can tap the Alaskan supplies economically in the next 20 years. Markets for Alaskan gas will depend on growing local use for residential, commercial, and industrial heating and for industrial uses other than heating (including electric-power generation) such as for manufacture of ammonia and other petrochemicals. Liquefaction of Alaskan natural gas for export to Japan and possibly other Alaskan and U. S. West Coast markets appears to offer the best basis for really large-scale use and should present attractive possibilities in the next few years. Projections of Alaskan output of natural gas in this report are based heavily on the successful outcome of this development, which, however, requires heavy capital outlays.

The more attractive business climate in the Area compared with that in many foreign countries should boost industry interest in developing its oil and gas resources.

Forests. Throughout Northwest North America the sheer volume of standing timber of merchantable grade and species is estimated at the impressive total of a trillion board feet. A wide variety of geographic and climatic conditions limits the proportion that is economically accessible at this time. Development of the accessible part in northern British Columbia and Alberta must rest on extensions of rail and highway systems there. Such transportation development, however, is not related to growth of the forest industries in Alaska, where the feasible and likely growth in the two decades to come will be limited largely to the Coastal Forest. Present and ready access already exists for this part of the Region in a usable combination of water freight and existing Canadian railways.

The demand for forest products of the type available from Northwest North American forests will condition the growth possibilities inherent in the Region. The Region as a whole should participate in the increasing world, continental, and local requirements for lumber, plywood, pulp and paper products, but this is not true of each segment of the Region. For example, Alaska should benefit by the full development of the Coastal Forest region by 1980, producing pulp and lumber valued annually at about $124 million and a population growth of about 25,000. There is also a possibility of newsprint being made in this area although the economics do not appear favorable at this time. But the lumber and plywood potential open to coastal Alaska will be supplemental to the major pulp industry. An expanding but only local use is foreseen for the forest products of interior Alaska by 1980.

A promising picture can be painted for the British Columbia and Alberta parts of the Region under study. There will certainly be an extension northward of the already well-developed lumber and pulp and paper industries south of the region. Huge volumes of relatively accessible, sound wood — depending on feasible new transport installations — combine with increasing world demand to make this a logical proposition. Pulp and lumber output are projected by 1980 to a total of about $320 million annually for these two areas, with population increasing by about 57,000.

It is not anticipated that either the Yukon or the Northwest Territories will participate in other than local development within the time period considered.

Over-all, then, and from the point of view of new or major additions to existing transportation facilities possibly needed to promote regional growth based on forest industry, it appears that no such facilities are required to maximize the potential of coastal Alaska, while the installation of such facilities still would not benefit interior Alaska. However, new transport in the way of railways and highways is vital in to realize the potential of northern British Columbia and northwestern Alberta.

Metals and Minerals. Total values of metals and minerals, excluding fuels, produced in the Area in 1958 were about as follows: Alaska, $15 million; Yukon Territory, $12 million; and Northern British Columbia, $10 million. Major minerals comprising these values were: gold, sand and gravel, stone, platinum, and mercury in Alaska; silver, gold, lead, and zinc in Yukon Territory; and asbestos and silver in British Columbia.

Except for the relatively few commercial producers and the possible developments discussed below, the known metal and mineral deposits in the Area are generally either too low grade if they are large enough or are too small if grade is sufficiently high to allow for commercial development under present market conditions. By and large, prices should not change materially in the next 20 years. High costs for labor, equipment, and supplies in the Area, especially Alaska, are a serious obstacle to mineral development.

The one outstanding assured new operation is that of Canada Tungsten Mining Company in Northwest Territories north of Watson Lake, which will produce some 2500 tons of tungsten concentrates per year worth about $3.2 million starting in 1961.

Beyond this, best short-term prospects for commercial operation are the iron deposits of Southeastern Alaska. The medium-grade ore in relatively small deposits (a few million tons each) may produce 600,000 tons annually worth $4.3 million, and the large low-grade titaniferous ore deposits (hundreds of millions of tons each) may produce some 2.3 million tons of concentrates per year valued at $18.8 million, with main market potentials in Japan or the U. S. West Coast. If large blocks of electric power could be made available at around 4 mills per kwhr it is plausible to think in terms of a substantial pretreatment electric-smelting operation producing, say, 1 million tons of steel per year worth about $73 million at Klukwan (20 miles northwest of Haines) for marketing on the U. S. West Coast in the next 5 to 10 years. Smaller blocks of low-cost electric power might be utilized to smelt iron-ore concentrates at Snettisham (40 miles southeast of Juneau) in a much smaller operation producing, say, 175,000 tons of pig iron annually worth about $8.7 million. The huge low-grade titaniferous iron deposits at Union Bay on Cleveland Peninsula have been extensively explored, but do not appear as attractive for commercial development as the deposits just cited.

Mercury prospects in the Kuskokwim River region might well develop into several new producers within 20 years, with total output of, say, 12,000 flasks annually worth some $2.5 million. Output could be flown out as from the Red Devil at present, but trucking over a new access road would be much cheaper.

It is likewise plausible to visualize development of the Vangorda Creek lead-zinc-copper deposit (northwest of Ross River) in Yukon Territory in the next 5 years, producing around 70,000 tons of concentrates worth around $8 million annually, for shipment through Whitehorse and Skagway to Vancouver and Trail, B. C. The Hyland River zinc-lead-silver deposit north of Watson Lake might be opened up at a lower operating rate.

The Tulsequah Chief zinc-lead mine on the Taku River in British Columbia near the Alaska border might be reopened if a road is extended up Taku Inlet and the Taku River near it, giving access to tidewater the year around. Output could amount to about 30,000 tons per year of concentrates valued at about $5 million.

Within perhaps 8 to 10 years the Clinton Creek asbestos deposit north of Dawson, Yukon Territory, might well be developed, with an output of some 30,000 tons of asbestos fiber annually worth $8 million, shipped to Whitehorse, Skagway, and Vancouver.

Four low-grade copper deposits – Sumdum (50 miles southeast of Juneau); Kobuk (some 150 miles east of Kotzebue Sound in northwest Alaska); Scud River A, and Scud River B (some 50 miles south of Telegraph Creek, B. C.) – might be exploited starting some 10 to 15 years hence, producing at an assumed rate of 10,000 tons of ore daily or say 108,000 tons of concentrates at Sumdum and each Scud River deposit, worth about $16 million per year and 162,000 tons worth $24 million from Kobuk (because of higher grade). Also, the Granduc copper property (northwest of Stewart, B. C.) might well be developed in 5 to 10 years, with an assumed output of around 10,000 tons of ore daily, or around 195,000 tons of concentrates worth $29 million per year. These would move to the coast for shipment probably to the Tacoma copper smelter.

Vast high-purity limestone deposits on numerous islands in Southeastern Alaska may well be developed for shipment to the Pacific Northwest or for use in Alaska, and more limited deposits in the Rail belt may well be exploited for manufacture of portland cement. Plans for such a plant near Anchorage were announced in the summer of 1960. Projections are included for 500,000 bbl of cement worth $3 million and 1.5 million tons of limestone from Southeastern Alaska worth $1.5 million annually by 1980.

Except for Kobuk, Kuskokwim mercury, Vangorda Creek, Canada Tungsten, and Clinton Creek, all the deposits are on or reasonably close to tidewater. New connecting roads would be needed by all exceptions named above, plus the Scud River deposits.

In addition, small operations might be developed in southwestern Yukon Territory at Quill Creek (nickel-copper worth, say, $3 million per year) and Canalask (nickel worth, say, $1.5 million per year), and future development might indicate substantial producers of copper at Johobo (south of Haines Junction) and of copper-nickel at Brady Glacier (northwest of Juneau). Known tin deposits on Seward Peninsula can supply small amounts of this strategic metal, but only at prices substantially above current levels.

All of those listed, however – except for Canada Tungsten – are highly conjectural developments, the outcome depending on the nature of competitive discoveries and developments elsewhere in the world and on assumed market growth. It is quite possible that none of them will be developed within 20 years.

Thus, any assured metal or mineral developments of major size in the Area are quite completely dependent on finding deposits that are larger and/or higher grade than those now known. A map (Figure V-10) is presented showing estimated metal and mineral lode potential for the Area as a crude guide for pioneering or development road location.

Although some large mining companies that have been actively exploring the Area are disappointed with results and speak of their experiences as disappointing, others are quite optimistic and consider the Area good "hunting ground" for discoveries. In view of widespread mineralization in many parts of the Area, there is still the strong hope of making one or more new fabulous finds comparable with the United Keno Hill and Kennecott deposits.

But in this metal "hunting" game, again, the Area must compete for exploration dollars with other areas throughout the world, and, to be realistic, the Area has its drawbacks. Mountainous terrain, short seasons, fickle weather, scarcity of lakes or landing strips for airplane travel, and remoteness combine to make prospecting in much of the region more costly by far than in many other geologically attractive areas, such as the Precambrian Shield of northern Canada.

Nevertheless, exploration is being pushed in the Area by mining companies. Recent social and political developments in many foreign areas have augmented the risk factor in developing and conducting enterprises abroad. Continuation of this trend might well cause mining companies to expand their exploration efforts in Northwest North America, where the "business climate" is more attractive and relatively secure.

More intensive effort by government geological departments in completing semi-detailed geologic mapping of the region would be a boon in attracting and guiding more intensified exploration by industry. Such work by government is urgently needed and fully warranted.

Coal. Limited exploration allows only crude order-of-magnitude estimates of coal reserves in the Area, but such estimates indicate the presence of about 100 billion tons of coal, about 80 per cent of which lies in northern Alaska along the north slope of the Brooks Range. About three-fourths of the total is low-rank subbituminous coal or lignite.

Coking-quality bituminous is known to occur in various areas, especially in northern Alaska, in the eastern end of the Matanuska district, and in the Bering River field along the Gulf of Alaska east of Cordova.

Production has come from the Nenana (subbituminous) and Matanuska (bituminous) districts in the Rail belt of Alaska, but this faces stiff competition from the newly discovered gas on the Kenai.

Best chance of developing a sizable operation appears to be in the Bering River district for production and export of low-volatile coking coal to Japan or other areas. Geological exploration and tonnage sampling was performed in 1959. Laboratory tests of the samples indicated acceptable coking characteristics. Further drilling and underground development of the highly folded, faulted, and crushed deposits will be needed to prove up the necessary tonnage of satisfactory grade minable at costs required to meet market demands. The Jewell Ridge Coal Company is giving further consideration to undertaking such a program. With favorable results, plans visualized could develop into an operation producing some 1 million tons annually worth about $10 million.

Reserves in the Canadian parts of the Area total about 4.4 billion tons, about half of which is bituminous grade in northern British Columbia and a third is lignite, mainly in northern Yukon. Major deposits in British Columbia are in the Groundhog, Peace River, Telkwa, and Atlin areas. About 400 million tons of largely subbituminous grade occur in the Peace River area of Alberta. Competition of natural gas, oil, and hydro power in the Peace River and northern British Columbia areas will limit the use of these Canadian coal deposits, but small tonnages may be used for smelting Hines Creek iron deposits in Alberta.

Outlook for sizable operations to produce steam coal for export is not promising. Relatively small operations in various parts of the Area will continue to serve local needs.

Hydroelectric Power. The water-power resources of Northwest North America represent one of the world's largest potentials for the development of hydroelectric power. The full potential of the Area is not yet known, but studies completed to date indicate a total potential capacity of some 30 million kw rated as installed capacity. Inclusion of numerous small potential sites of 2000 kw or less and revision of original estimates for others would augment this total.

Compared with Alaska's total of almost 19 million kw of undeveloped potential hydro power, only a minute amount of about 66,000 kw had been developed as of 1958. Most of this developed hydro power is now being utilized by utilities. Fourteen undeveloped sites have potentials of over 100,000 kw each, headed by Rampart Canyon, northwest of Fairbanks on the Yukon, rated at 4.7 million kw installed capacity. This is followed in size by Woodchopper Creek and Kaltag in the Yukon basin; by Wood Canyon and Peninsula on Copper River; and by Devil Canyon, Denali, and Watana on Susitna River.

The total potential in Canadian parts of the Area is about 8.8 million kw, with 11 sites rated at over 100,000 kw at maximum flow. Heading these in size is the Portage Mountain site on the Peace River near Hudson Hope with 3 million kw, followed by the Stikine River, then by 8 sites on the Yukon.

The Peace River site has been studied intensively in recent years by the Peace River Power Development Company, Limited (Wenner-Gren interests), and application has been made to the British Columbia government for permission to proceed with plans to construct a dam forming a lake that would flood the Rocky Mountain Trench a distance of some 200 miles. Generating capacity would be 3,145,000 kw, and a 500,000-volt transmission line would connect the plant with the transmission system of the British Columbia Electric Company at Lillooet, some 450 miles to the south. Technical proposals have been accepted, with minor changes suggested, by the British Columbia Water Comptroller, but economics and financing plans still had to be approved in the fall of 1960 by the British Columbia Public Utilities Commission. The project would not be completed until 1976. Considerable controversy has arisen over these plans, with many informed persons claiming that development of the Upper Columbia River under international agreements with the U. S. would offer more attractive economics for the next stage in power developments in that area. Certainly the growing electric-power demand of southern British Columbia will require one or the other in the next decade, and there are many who claim that power from both the Peace and Upper Columbia Rivers will be needed by the time both could be constructed (some 15 years).

Two attractive sites that also received much study for planned development in the past decade involve damming the Yukon near Whitehorse and diverting its headwaters by tunneling and dropping the reversed flow to the Pacific Ocean with heads of some 2,000 feet. Since both would tap largely the same water sources, the potentials are not entirely additive. The Yukon-Taiya project near Skagway, Alaska, would require international agreements between Canada and the U. S. With a potential of some 1.2 million kw, this project was studied and proposed by the Aluminum Company of America in the early 1950's for aluminum reduction use, but was dropped when agreement with Canada could not be arranged. The Taku project, east of Juneau, with an estimated ultimate installed capacity potential of 3.6 million kw, was studied by the Frobisher-Ventures-Quebec Metallurgical interests in the mid-1950's for power use by a complex of electrometallurgical and electrochemical industries, but was dropped when interest by large power users failed to develop. This latter project might also involve international agreements because of required changes in flow in the Yukon and Taku Rivers.

Costs of these large hydroelectric projects run into the hundreds of millions of dollars, topped by Rampart, which has been roughly estimated to cost between 1 and 1.5 billion dollars. Cost of power at the sites, even with reasonably high load factors, will probably amount to from 2 to 4 mills, and if the power is transmitted very far costs of one to several mills may be added. Costs of power at most of the smaller sites are not low (below 5 mills per kwhr), but generally are estimated as somewhat high (above 10 mills per kwhr). Capital costs of thermally generated power plants are far below those for hydro power, and it is altogether possible that thermally generated power from recently discovered natural gas or from more cheaply mined coal in southern Alaska may be highly competitive with hydro power in supplying small- to medium-sized demand. Much less time is needed to construct thermal than hydro plants.

Prospects for use of hydro power in the Area by large electrometallurgical and electrochemical industries making such products as aluminum, ferroalloys, iron and steel, calcium carbide, chlorine, caustic soda, and phosphorus, are not encouraging. This reduced interest stems from: (1) the fact that hydro-power costs have risen substantially in the past decade while costs of thermally generated power in or near product-consuming areas have remained about the same or even been reduced, with the severe shrinking of the margin between the two; and (2) the growing interest in use of hydro or thermally generated power in other parts of the world closer to available resources, coupled with nationalistic trends abroad that force more and more use of local power to process indigenous raw materials to higher levels of manufacture. Based on known occurrences, Northwest North America is deficient in the major raw-material resources processed by these large power-consuming industries, and the distant location from resources and markets is a severe obstacle to power usage in the Area. The most promising possibility is for use of around 200,000 kw for electric smelting of the large iron deposits near Klukwan to produce, say, 1 million tons of steel annually; but the hydro project would have to be financed by other parties and power supplied at around 4 mills or less per kwhr to make this at all attractive.

In summation, the future energy-use picture in Northwest North America will be characterized by increasingly keen competition among the various energy sources — hydro, coal, gas, and oil, with nuclear sources perhaps becoming competitive in isolated locations a bit farther in the future. This competition is concerned at present with very limited local markets in the Area, and even a doubling or quadrupling of such local markets in the next 20 years will still amount to only relatively small demands. Markets for large blocks of the potentially low-cost hydro power in the Area may develop for processing materials, but this power must compete with huge potentials of cheap hydro and thermal power elsewhere in the world. Transmission of large blocks of hydropower from the Peace River region to heavy power-using areas to the south is quite possible by 1980.

Fish. The fisheries of Northwest North America, confined primarily to the coasts of Alaska and British Columbia, contribute significantly to the economy of the Area — $33.1 million in Alaska, and $49.6 million in British Columbia for value of catch in 1958. In addition to these values of catch, the processing of fish, primarily canning of salmon, produced wholesale values of $84 million in Alaska, and $98.2 million in British Columbia for that year.

There have been better years than 1958, but contrary to some dire predictions that the industry will continue its decline, even to virtual depletion, improved research methods and better control measures by the industry itself and by governmental supervisory agencies are demonstrating that healthier conditions for the industry are developing. The sharp rebound in the Bristol Bay salmon catch in 1960 supports this belief. In view of these developments it has seemed reasonable to predict an increase in value of catch of $14.1 million in Alaskan fisheries and $7.9 million in British Columbia, annually by 1980.

By and large, transport needs are adequate for the fisheries, located as they are along the coast. The patterns of distribution for canned and frozen fish do not indicate any likely appreciable change, by virtue of new roads in Alaska, from the use of rail from Prince Rupert or truck and rail from Seattle in reaching markets to the east. It is considered possible that some refrigerated fresh-fish products and some frozen fish would be shipped over an alternate highway routing from Southeastern Alaska, if made available, but the possible tonnage involved is insufficient to lend strong support to a decision to build a road.

Furs. Until recent years, the values of furs produced in Northwest North America have represented significant contributions to the economy of the Region. For Alaska the Pribilof fur seals have constituted the major portion of total fur values, but the number of seal pelts has dropped drastically during the past 4 years. In all of Northwest North America wild fur trapping continues to be an important source of livelihood for the Eskimo and Indian, although subject to erratic yearly fluctuation in cash return because of changing prices, fashion change, and other factors. Fur farming has appeared to grow in importance, but it, too, has been subject to uncertain profitability. Improved transportation facilities are unlikely to contribute effectively to bettering the fur business in the Area.

Agriculture. For various reasons, such as distance from large markets and farming supply centers, small and erratic local populations, and climatic conditions, agricultural development in Northwest North America has been slow. In Alaska, only about 8 per cent of local needs are satisfied from local production, compared with a physically possible degree of self-sufficiency estimated near 50 per cent, although 25 per cent appears to be a more realistic goal. Farm production in northwestern Canada, primarily in British Columbia and Alberta, accounts for less than 10 per cent of the total agricultural production of these provinces, and is confined essentially to grain and forage seed crops in northwestern Alberta, and is divided about equally between animal products and field crops in northern British Columbia.

Transportation needs for agricultural development in Alaska are primarily for improved roads to make service to local markets easier. Lower transportation costs between Alaska and the lower 48 states would be most helpful in regard to lowering costs of farm machinery and supplies, but initially would be expected to increase the advantages of imports over local production of agricultural foods. In northwestern Canada, some improvement of local roads would improve the internal distribution of agricultural products and farm supplies, but for the principal production areas transportation facilities to major outside markets are deemed adequate and no deterrent to agricultural expansion.

Adequate agricultural development to meet the attainable needs of the Area's growing population in the next 20 years can be met by (1) more intensive operations on presently occupied and cleared land, (2) operations on presently occupied but uncleared land, (3) operations on unoccupied, uncleared land along present roads, and (4) operations on nearby extensions of present road systems. In no case would construction of new major internal highways be justified for the express purpose of developing agriculture in distant areas, since most of the potential acreage needed for expansion is within or adjacent to existing settlements.

Resource-Based Manufacturing and Related Industries

The possible effects of potential resource development on the economy of each segment of Northwest North America by 1980 are shown in Table I-1. These are expressed in terms of estimated increases in basic industry workers, population, tonnage output, value of product, and payrolls. As can be seen, the effects could be very gratifying over the next 20 years for the Area as a whole, and for Alaska, northern British Columbia, and northwestern Alberta in particular. Since less is known about the Yukon and Northwest Territories, the future there may only need an increased exploration effort to create significant numbers for the Territories' development potential.

For Alaska the significant numbers are those showing a total possible population increase resulting from resource-based industries of about 170,000 persons and increased payrolls in these industries of about $210 million annually, by 1980. In addition to the direct industrial-payroll increases, there should be an almost equivalent amount paid to those working in supporting activities and services, since the assumption has been made that one industrial worker generates the need for one secondary industry or service worker. An estimated total payroll increase, then, of $420 million annually would thus be developed. Total value of new product of the basic industries has been estimated at about $596 million, annually.

In northwestern Canada the total population increase by 1980 could be 168,000 and increased payrolls in resource-based industries could be $139 million by then. On the basis of the 1:1 ratio of basic to supporting workers previously used, there would be an approximate payroll increase of $278 million. Total value of new products of the basic industries in northwestern Canada has been estimated at about $818 million annually.

Thus, for all of Northwest North America, development of resource-based industries could bring about a total population increase of about 338,000 and a total annual payroll increase for these industries of about $350 million by 1980. Value of new products of the basic industries has been estimated at over $1,400 million annually by 1980.

These numbers could be quite conservative if new major discoveries and developments of the resources should come about, although there are included in these estimates some highly conjectural metal and mineral developments. Also, drastic changes in the military and government construction picture could greatly influence such operations as coal mining, cement manufacture, lumbering, and others. The outcome of

TABLE I-1. ESTIMATED INCREASES IN POPULATION, ANNUAL OUTPUT, ANNUAL VALUE OF PRODUCT, AND PAYROLLS THROUGH RESOURCE DEVELOPMENT, BY 1980

Industry	Alaska					Yukon and Northwest Territories				
	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase
Metals and Minerals										
Iron Ore	2,925,000	23.0	950	-	5,700	-	-	-	-	-
Copper	270,000	40.0	900	-	5,400	-	-	-	-	-
Lead, Zinc, Silver	-	-	-	-	-	70,000	8.0	300	-	1,800
Tungsten	-	-	-	-	-	2,500	3.2	150	-	900
Mercury	500	2.5	100	-	600	-	-	-	-	-
Asbestos	-	-	-	-	-	30,000	8.0	400	-	2,400
Nickel and Copper	-	-	-	-	-	8,000	3.0	50	-	300
Limestone	1,500,000	1.5	100	-	600	-	-	-	-	-
Total Metals and Minerals	4,695,500	67.0	?,050	13,700	12,300	110,500	22.2	900	4,850	5,400
Coal	1,000,000	10.0	400	4,000	2,400		Minor			
Oil	25 million bbl	60.0	3,500	32,000	21,000		Unknown			
Gas	100 billion cu ft	15.0								
Forest Products										
Pulp	600,000	90.0	3,500	26,000	21,000		Minor			
Lumber	66 million bd ft	6.6	600	3,900	3,600					
Fish (Catch)	200 million lb	14.0	None	14,000	None		Nil			
Agriculture	-	35.0	1,300	13,000	7,800		Minor			
Tourism	-	223.0	14,600	87,600	87,600	-	51.0	2,840	11,700	14,040
Miscellaneous										
Food processing	-	10.0	1,000	6,600	6,000		Unknown			
Electro process (1)	1,245,000	62.2	1,250	9,600	7,500	-	-	-	-	-
Cement	500,000 bbl	3.0	70	400	420	-	-	-	-	-
Total miscellaneous	-	75.2	2,320	16,600	13,920	-	-	-	-	-
Total, all resources	-	595.8	28,270	210,800	169,620	-	73.2	3,240	16,550	19,440

Industry	Northern British Columbia					Northwestern Alberta				
	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase
Metals and Minerals										
Iron Ore	-	-	-	-	-	350,000(2)	25	500	-	3,000
Copper	411,000	61.0	1,600	-	9,600	-	-	-	-	-
Lead, Zinc, Silver	30,000	5.0	100	-	600	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-	-	-
Mercury	-	-	-	-	-	-	-	-	-	-
Asbestos	-	-	-	-	-	-	-	-	-	-
Nickel and Copper	-	-	-	-	-	-	-	-	-	-
Limestone	-	-	-	-	-	-	-	-	-	-
Total Metals and Minerals	441,000	66.0	1,700	9,200	10,200	350,000	25	500	2,100	3,000
Coal		Minor						Minor		
Oil	50 million bbl	120.0	5,000	26,000	30,000	55 million bbl	132.0	3,500	18,600	21,000
Gas	400 billion cu ft	60.0				153 billion cu ft	23.0			
Forest Products										
Pulp	525,000	81.0	3,100	13,000	18,600	420,000	63.0	2,410	8,700	14,460
Lumber	213 million bd ft	21.3	1,980	6,600	11,880	213 million bd ft	21.3	1,980	6,600	11,880
Fish (Catch)	90 million lb	8.0	None	8,000	None			Nil		
Agriculture	-	4.0	-	-	None	-	16.0	-	-	None
Tourism	-	99.0	4,390	21,950	26,340	-	5.5	275	1,375	1,650
Miscellaneous										
Food processing		Unknown						Unknown		
Electro process (1)	-	-	-	-	-	-	-	-	-	-
Cement	-	-	-	-	-	-	-	-	-	-
Total miscellaneous	-	-	-	-	-	-	-	-	-	-
Total, all resources	-	459.3	16,170	84,750	97,020	-	285.8	8,665	37,975	51,990

(1) Includes pig iron, steel and calcium carbide. Value shown for pig iron and steel represents value added by manufacture, not including value of iron concentrates shown at top of table.
(2) Steel.

foreign-trade promotion and negotiation, particularly with the Far East, could have a considerable effect on the minerals, forest products, fertilizer, petrochemicals, and other industrial developments. Finally, since the effects of tourism development loom large in the estimated totals, all of the segments of Northwest North America must be as cooperative as possible in developing and improving transportation facilities, tourist accommodations and services, and promotional activities if tourism is to make the hoped-for contribution to the over-all economy.

Projections of total population and value of products from principal industries in the Area in 1980, compared with data for the late 1950's, are given in Table I-2.

Present and Planned Transportation Facilities

Freight movements in and out of Northwest North America, totaling somewhat more than 2 million tons, are predominantly waterborne, with only minor tonnages by air and by long-haul trucks. Passenger movements, conversely, are mainly by air, with a fairly large portion by highway, and relatively few movements by water. Both freight and passenger movements have been undergoing change over the past decade, with freight being carried more and more by bulk cargo barges and van-barges at the expense of large dry-cargo ships, and with passengers moving more and more by highway at the expense of air carriers, percentagewise.

Improvements in transportation facilities that have lowered costs, increased speed, or brought about a combination of the two, and in the case of passengers traveling by auto, reduced discomfort, have induced such changes in the patterns of movement. Continuing and accelerated efforts to further improve transport service and costs are in evidence. Some of these are in the hands of private enterprise, notably the water and air carriers, while others, such as those affecting roads and highways, are being pushed by state, provincial, and federal governmental agencies. Several rail developments in Canada are being planned by both private groups and governmental agencies as follows: Pine Point on Great Slave Lake to connect with the Northern Alberta Railway; the Pacific Northern Railway to connect Summit Lake, B. C., north of Prince George on the P. G. E. with the British Columbia-Yukon border south of Whitehorse; and the northern extension of the P. G. E. from Fort St. John to the Beatton River area, and a possible connection with the Pine Point line at the British Columbia border.

Basically, pioneer development roads and roads to established resources receive preference in Canadian programs mainly on the premise that more miles of road can be built of this type (gravel) and that they serve a better initial purpose than more costly, paved highways. The paving process, it is agreed, can take place at a later date when volume of passenger traffic, requiring greater comfort, develops.

Alaskans are keenly interested in pioneer roads, but there is also great pressure to provide paved roads that permit more comfort and speed for tourist and intrastate residential travel. In view of the growth in tourist travel that is visualized and the dependence of this growth on considerable improvement in highway facilities, both as to miles and quality of road, programs to provide such improvement appear to be most appropriate. Coordination of state, provincial, and federal programs and policies is essential to the maximum realization of the benefits from each program.

TABLE I-2. PRESENT AND PROJECTED VALUES OF PRODUCTS IN RESOURCE-BASED INDUSTRIES, AND ESTIMATED TOTAL POPULATION 1958 AND 1980[a]

	Value of Indicated Products, millions of dollars									
	Metals and Minerals	Coal	Oil	Gas	Forest Products	Fish (Catch)	Agriculture	Tourism (Expenditures)	Total	Population
Alaska										
1958	21.4	7.0	Minor	Nil	27.0	33.1	4.7	66.0	159.2	224,000 (1960)
1980	88.4	17.0	60.0	15.0	123.6	47.1	39.7	289.0	755.0[b]	393,620[b]
Yukon and Northwest Territories										
1958	11.8	Minor	1.0	Nil	Minor	Nil	Minor	5.9	18.7	12,200 (1956)
1980	34.0	Minor	Unknown	Unknown	Minor	Nil	Minor	57.0	91.0	31,640
Northern British Columbia										
1958	9.8	Minor	1.0	3.9	117.0	49.6 (1956)	7.7	7.0	196.0	57,700 (1956)
1980	75.8	Minor	121.0	63.9	219.3	57.6	11.7	106.0	655.3	154,720
Northwestern Alberta										
1958	Nil	Nil	12.9 est.	3.6 est.	16.0	Nil	32.6 (1956)	14.5	79.6	70,000 (1956)
1980	25	Minor	144.9	26.6	100.3	Nil	48.6	20.0	365.4	121,990
Total in 1980	223.2	17.0	325.9	105.5	443.2	104.7	100.00	472.0	1,866.7[b]	701,970[b]

(a) Source: Bureau of the Census, Dominion Bureau of Statistics, Alberta Bureau of Statistics, British Columbia Bureau of Economics and Statistics, Battelle estimates.
(b) Total value of product and total population figures for Alaska and Area in 1980 include $75.2 million and 13,920 persons, respectively, arising from food processing, electroprocessing and cement manufacture shown in Table I-1.

Note: Above estimates, especially of population, assume continuation of military and Government activities at about 1959 levels for the period 1960-1980.

The Southeastern Alaska ferry system has received long and serious study in the past, and has not been analyzed in this study. It is considered to be a planned project. It involves daily service from Prince Rupert to Haines and Skagway (less frequent in the winter), with intermediate stops at main communities enroute, and side service to off-the-route communities such as Sitka. The trip would take about 24 hours, and vessels would include only reclining seats and snack bars, with no berths for sleeping or elaborate dining facilities. Autos and trucks would also be carried. With the major southern terminus at Prince Rupert, the project has strong international features, with considerable benefit to Canada stemming from traffic flowing to and from the ferry through that area.

Canadian interests are planning a ferry connection between Prince Rupert or Kitimat, B. C., and Port Hardy on Vancouver Island, the northern terminus of a highway to Victoria. Such a ferry and highway route would further shorten the Seattle-Fairbanks distance. The effectiveness of these systems alone should be quite noticeable when completed, but it is not difficult to visualize even greater benefits when other programs are completed to complement their functions.

Much of the planning being done by water carriers, particularly that involving transport of large containers, vans, and trailers, depends on the development of improved highway facilities from terminals in Northwest North America to interior communities and resource development sites. Railroads are developing serious plans for extending rail-barge service to more areas in Southeastern Alaska.

Needless to say, some of the facilities being planned and constructed tend to produce competitive pressures that in the long run should benefit consumers and producers in Northwest North America. Initially, however, some of these competitive facilities will be dividing volumes of business barely large enough now to support just one of the facilities.

Major Potential Transport Improvements

At the request of the Commission, detailed studies of location and costs of transportation improvements needed in Northwest North America for resource development were confined to major facilities linking Alaska with the southern 48 states plus major feeder routes tying to such links. The studies on costs versus benefits of transport facilities could be made only on the relatively few routes that appeared to have the highest degree of economic feasibility without attempting to probe such ratios for all possible routes.

In general, analyses of the major resources in the Area indicate that, except for timber, oil, and gas in British Columbia and Alberta, developments based on known resources will occur over the next 20 years in areas along or close to the coast. This is true for metals and minerals, forests, coal, oil and gas, and fish. If major freight movements result from future discoveries of mineral resources in regions back from the coast in Alaska, Yukon Territory, and in northwestern British Columbia, these could be handled most economically by shipping to the coast over the shortest possible route available at that time and thence to markets by water transport. Tourism is thus the only major economic-development potential in the Area that would benefit substantially from major new or improved land-transport linkages between Alaska and the southern 48 states.

Highways. Cost summaries of the various highway sections comprising the integrated highway system needed to provide the convenience and flexibility of movement to attract the number of highway travelers foreseen as possible by 1980 are as follows:

(1) Alaska Highway. Relocating and upgrading, where necessary, and asphalt surface treating from Charlie Lake (north of Ft. St. John) to the Yukon Territory-Alaska boundary, a distance of 1169 miles. Cost of improvements is estimated at $102.3 million, including $1 million for replacement of a bridge south of Charlie Lake. During 1960, about 30 miles of the highway north of Charlie Lake was paved, so the cost estimate would now be somewhat less. Distance from Seattle to Fairbanks via this route is 2367 miles.

(2) Constructing an asphalt-surface-treated highway (Route 5) connecting Hazelton, B. C., with the Alaska Highway at Jakes Corner, Y. T., using a section of the Stewart-Cassiar Road now under construction and upgrading the present road from Atlin to Jakes Corner. Estimated cost is $60.2 million. Distance from Seattle to Fairbanks by this route would be 2081 miles, or 286 miles shorter than via the Alaska Highway. On the other hand, distance to Fairbanks from all points south and east of Edmonton, Alberta, by this route would be 225 miles farther than by using the Alaska Highway. Eventual completion of the road between Jasper, Alberta, and Prince George, B. C., as planned, will result in actually shortening the distance to Fairbanks from the east and south, going via the Hazelton-Jakes Corner route. This route would pass through Calgary, but would bypass Edmonton. But Alberta also has plans to cut a road southeast from near Grand Prairie to Calgary, shortening the route via the Alaska Highway. Effects of these developments on automobile travel to the Area have not been studied in detail; they would contribute importantly, however, to the effectiveness of the integrated highway system in attracting tourists to the Area.

(3) Constructing a new asphalt-surface-treated highway from Popof Creek (eastern end of programmed Mitkof Road along the north bank of the Stikine River near the British Columbia-Alaska boundary) up the Stikine and Iskut Rivers to a junction with the Stewart-Cassiar Road. Distance is estimated at 96 miles, and construction cost at $23.8 million.

(4) Relocating, upgrading, and asphalt surface treating the Haines Cutoff from 23.3 miles north of Haines, Alaska, to Haines Junction, Y. T. Present distance is 159 miles, and the total distance using the relocated 40-mile stretch would be reduced to 143 miles. Estimated cost is $16.5 million.

(5) Constructing a gravel road from Juneau up Taku Inlet and the Taku River to the British Columbia boundary and constructing a new asphalt-surface-treated highway to a junction with the proposed Hazelton-Jakes Corner road south of Atlin. Location and costs were studied only for the Canadian portion, since Alaska highway officials have surveyed the Alaskan part. Distance from Juneau to the Canadian border is 52 miles,

and from the Canadian border to the junction point south of Atlin, 71 miles. Costs are estimated as follows:

For Canadian Section	$17.6 million
For Alaskan Section, estimated by Alaska officials, including ferry and facilities	20.0 million
Total	$37.6 million

Costs are also given in the report for these and other alternate routes from Hazelton to Jakes Corner for a gravel highway and for a highway paved with 2 inches of asphaltic concrete.

There is considerable description in the report of problems of highway construction and maintenance in the Area, and more details are given in Supplement I, the report by Brown & Root, Inc., of Houston, Texas, who made the preferred location and cost studies for Battelle. Reasons are given for preferring the asphalt-surface-treated highway over the asphaltic-concrete-paved highway. Conclusions of Brown & Root are that year-round maintenance costs for a paved or surface-treated highway will be roughly similar to those for a gravel highway, with a realistic over-all average of about $2500 per mile per year.

Typical examples of intra-Alaskan roads of special value to resource development are also given, with rough location and cost estimates presented. Such might be typified by a secondary, "pioneering" road extending from Browne (south of Rex) westward and southwestward through Kantishna, skirting the north slope of the Alaska Range to the vicinity of Farewell; thence northwest to McGrath and north to Ruby; thence east to Tanana, where it would join with a proposed road from Eureka to Tanana for which route design studies have been made by Alaska. Such a route would provide access to and spur exploration for minerals in the adjacent favorable areas in the Alaskan Range and Kuskokwim Mountains. Cost of such a 572-mile secondary gravel road is roughly estimated at $39 million.

Rail Connections Between Fairbanks and Canadian-U. S. Rail Network. Without any implications as to its economic feasibility, since costs-benefits were not studied by Battelle, the Pacific Northern Railway is considered in this report as a planned facility. This would extend from near Prince George northwestward to the Yukon Territory-British Columbia boundary about 80 miles southeast of Whitehorse. Cost of this 697-mile railway, as reported by Colonel Bingham to the Wenner-Gren British Columbia Development Company, Limited, would be about $250,000,000, or about $360,000 per mile of main line. Costs could be reduced if some of the less essential specifications were lowered somewhat.

Appraisals of known resources indicate that potential freight traffic to 1980 along a railroad between the Y.T.-B.C. boundary and Fairbanks would be quite limited, raising serious question as to the economic feasibility of such an enterprise. Any sizable freight movements arising from future resource discoveries would probably move most economically via shortest route to tidewater and thence to markets by water shipment - especially true for shipments involving Japanese interests and markets.

Rough cost estimates were made for a railroad linking Whitehorse with the terminus of the Alaska Railroad at Eilson Air Force Base southeast of Fairbanks. The route chosen was northward from Whitehorse near the Mayo Road to Carmacks, thence following the route surveyed by the U. S. Army Corps of Engineers in 1942 along the Yukon, White, and Ladue Rivers to join the Alaska Highway route just east of Tetlin Junction (about 20 miles east of Tok Junction). Distance from Whitehorse to Eilson would be about 590 miles, and estimated cost at $250,000 per mile would total about $147,500,000. Assuming interest charges of 5 per cent and amortization over a 50-year period, annual charges for capital recovery would be about $8 million. Annual operating costs at an assumed $15,000 per mile would total about $8.9 million which could be reduced substantially by strict economies and possible joint operations with the PNR and Alaska Railroad. Total annual charges would approximate $16.9 million at the assumed $15,000 per mile operating cost rate. Annual passenger revenues are estimated liberally at $400,000, leaving about $16.5 million per year to be met by freight traffic.

Most of the limited known potential tonnages to and from the Fairbanks area and east central Alaska would probably continue to move most economically over rail and truck via Anchorage, Seward, or Valdez, rather than by a much longer rail haul via Whitehorse and Skagway. Best potentials for freight movement over a Whitehorse-Fairbanks railroad would be from western and central Yukon Territory; Battelle can visualize a maximum potential by 1980 of some 300,000 tons annually, based on development of known mineral resources and supplies needed for their exploitation for movement over such a line, with an average length of haul of around 200 miles. Much of this potential might continue to be moved by truck to Whitehorse. At an average revenue of 5 cents per ton mile, dictated by present competition of efficient large-scale trucking of minerals and supplies, such a freight volume would provide total annual revenue of about $3 million — short by $13.5 million of meeting total revenue for break-even operation, or by $5.5 million if amortization and interest charges are omitted. These figures would be lowered to $8.8 million and $0.7 million if operations costs were lowered to $7,000 per mile.

Indirect benefits could include: (1) taxes from railroad employees' income and from service industries and employees generated by the rail employees, (2) taxes from expenditures made in Canada and Alaska by tourists traveling over the railroad, (3) possible rental of right-of-way for pipe lines or power lines and of communications system, and (4) taxes from increased land values and industries generated by the presence of a railroad. These involve either minor benefits or such highly conjectural factors as to preclude the making of meaningful future estimates.

If the railroad were financed by Canadian and U. S. governments, with possible omission of annual amortization and interest charges, annual financial operating statements might appear more attractive as cited above. But unless the indirect benefits can equal these interest and amortization charges (and much time would be required to attain them at best), such treatment must be considered virtually an outright subsidy, since governments, like anyone else, must pay for the use of money, via the tax-paying public.

For pioneering purposes in "opening up" a country with resources yet unproved, Battelle feels that economics favor the use of a moderately good highway served by efficient motor transport, which also serves the automobile tourist traffic. Railroads can be appropriately considered when large tonnages of resources requiring rail transport are proved through developments sparked by transport via highways.

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Costs Versus Benefits of an Integrated Highway System

The "Tourism" section points out the severe limitations of present surface transportation as a mechanism for attracting really large numbers of motorists to the Region comprising this study. Using these components as a base, however, it was possible to evolve a complete system that would have the necessary flexibility and convenience to attract by 1980 an estimated 370,000 highway passengers from outside the Region to Alaska and an estimated 350,000 highway passengers from outside the Region to Canadian destinations.

The major components of this integrated system are the Alaska Highway and a new highway (Route 5) from Hazelton, B. C., to a junction with the Alaska Highway at Jakes Corner. To be attractive, both of these highways would need to be upgraded to provide a paved surface suited to high-speed travel and convenience. The needed flexibility of the system would be obtained (1) through feeder routes from Route 5 to the Petersburg-Wrangell area and to the Juneau area, (2) through improvements of the Haines Cutoff to make all-year travel more practical, and (3) through installation of the planned Southeastern Alaska and Port Hardy ferry services.

Estimated costs for this system, exclusive of the costs of the ferry systems which are assumed to be self-supporting, are about $240 million. Annual amounts needed to recover the capital investment over a 20-year period at a 5 per cent interest rate would be about $19 million.

Annual maintenance costs for the estimated 1969 miles in Canada plus 85 miles in Alaska would be about $5 million, at an assumed average annual maintenance cost of $2500 per mile. On the other hand, over 75 per cent of the proposed system comprises upgrading existing roads (plus the Stewart-Cassiar Road) already requiring annual maintenance. Assuming that maintenance costs for the upgraded roads would be roughly similar to present rates (see discussion by Brown & Root in Supplement I for more detail on this subject), new maintenance costs chargeable to the system would comprise 418 miles in British Columbia and about 65 miles in Alaska. Costs of maintaining the Haines Cutoff as an all-year road would also require substantial additional maintenance on about 60 miles in Yukon Territory and 40 miles in British Columbia.

Based on the foregoing assumptions and including the Canadian portion of the Haines Cutoff, new annual maintenance costs at $2500 per mile would be as follows:

British Columbia - 458 miles at $2500/mile = $1.15 million

Yukon Territory - 60 miles at $2500/mile = $0.15 million

Alaska - 65 miles at $2500/mile = $0.16 million

Estimated annual increased gasoline tax revenues by 1980, based on 1960 tax rates, that may be derived from interregional travelers within the Region would be about $3.9 million, distributed as follows:

Alaska - $1.1 million

British Columbia - $1.5 million

Yukon Territory - $0.4 million

U. S. Government - $0.9 million.

Each of these potential additional revenues is greater than the estimated cost of maintaining the new sectors of road within each governmental boundary. There would, of course, be additional tax revenues obtained from intra-Regional users of the system.

On the other hand, some portion of the revenue obtainable from interregional travelers should be apportioned to maintenance of other roads used by such travelers within the Region.

Tangible benefits to the Region would be derived from expenditures by interregional highway travelers within the Region. These expenditures are estimated to amount to about $280 million annually by 1980, of which $146 million would be spent in Alaska and $132 million in Canada.

Average tax revenues over the past several years as a percentage of Gross National Product (GNP) have been as follows:

U. S. Government - 15-1/2 per cent

State and Local Governments - 6-1/2 per cent

Canadian Government - 14 per cent

Provincial and Municipal Governments - 6 per cent.

Using these percentages as a basis, the total estimated revenues in 1980 obtained from expenditures by "outside" travelers in the Region would be about as follows:

U. S. Government	$23 million
Alaska State and Local Governments	9.5 million
Canadian Government	18.5 million
Provincial and Municipal Governments	8 million
Total	$59.0 million

Subtracting the estimated 1960 tax revenues of $7 million obtained from interregional highway travelers gives an estimated increase in annual tax revenue by 1980 of $52 million, or almost 2.5 times the annual costs of amortizing and maintaining the integrated system. If secondary and tertiary effects (repeated dollar turnover) on taxes obtained as a result of the expanded expenditures were taken into account, the tax returns over a period of years would, of course, be substantially greater. The estimated time for recovery of the capital costs involved in constructing the system at 5 per cent interest, including annual additional maintenance costs of $1.5 million, would be about 13 years.

In addition there would be many intangible benefits both to the traveler and to various sectors within the Region. Some of the more important intangible benefits would include (1) increased comfort and safety to the traveler, (2) improved access to forest areas and to probable mineral-bearing lands requiring intensive exploration to assess their true potentialities, (3) lower auto travel costs from reduced maintenance, (4) time saved enroute, (5) pleasures and freedom of land access by automobile between many more communities and recreation areas, (6) faster truck movement permitting more frequent and varied service and eventually lower rates, (7) improved intraregional and interregional communication at all seasons.

Financing the Program

The vast expanse of Northwest North America and the extremely low density of its population make it impossible to develop interregional highways whose traffic densities will be sufficient to recover the costs of building the roads through normal direct taxes on highway users. On the other hand, in the absence of a suitable transportation system both the rate of growth and the absolute economic development of the Region may be materially and unnecessarily retarded. This premise is, in fact, the primary reason for the present study. The findings indicate that travelers from outside the Region offer one of the best opportunities for economic growth of the Region and the principal resource requiring development of an improved interregional transportation system for its full economic potential to be realized.

It has been shown that the costs of new and additional maintenance requirements for the integrated highway system would be more than offset by the gasoline taxes within each governmental entity within the Region. Moreover, while financing of the building of the new and improved roads would have to be by appropriate governmental action, the estimated additional tax revenues obtainable from the expenditures of potential travelers within the Region would be substantially greater than the costs. More importantly the economy of the Region would be vastly expanded through generation of capital within the Region for its economic growth and well being and at a much earlier time than would be possible otherwise.

Virtually all of the program presented involves building of new roads in British Columbia and improving existing roads in British Columbia and Yukon Territory. On the other hand, Alaska would be the principal beneficiary from expenditures by interregional travelers within the Region, these estimated expenditures in Alaska being essentially equal to the combined expenditures in British Columbia and Yukon Territory. Benefits to be derived by inhabitants of the Region through use of the system would be substantial for all parties. Intangible but very real benefits would also accrue to visitors from other parts of Canada and the U. S., and other countries.

Because of the international considerations involved it would be inappropriate to suggest specific recommendations as to how government financing might be distributed among the various interested parties. This is a matter that can be decided only after proper international discussions leading to acceptance by the various governments of the premise that the proposed program would not only be self-sustaining but is deemed of sufficient importance and urgency to command the appropriation of the needed monies.

Conclusions

In a study as broad in scope of subject and covering as large a geographic area as the one being reported, conclusions can be very large in number, covering considerable detail. Much of this detail, in the nature of "conclusions", has already been included in the rather expanded preceding "Summary".

To be given here are the broader conclusions of major import in obtaining a concise picture of the results of the study. From the objective and realistic approach to and conduct of the study made by Battelle, the following conclusions have been drawn. These exclude any consideration of strategic military factors related to transport needs of the Area, and assume continuation of military and Government activities at about 1959 levels.

- Tourism offers the most promise for immediate and continuing returns that will contribute importantly to the economic health and growth of Northwest North America. By 1980, a potential of 850,000 travelers annually is foreseen for Alaska, plus an additional 550,000 having destinations in Canada. Increased expenditures by travelers within the Area should increase progressively to about $380 million annually. This growth can be attained only if great improvements are made in transport facilities, accommodations, services, and promotional activities.

- Based largely on plausible projections from presently known deposits, oil and natural-gas potentials for the Area are large and will make major contributions to the economic growth of the Area in a period 5 to 20 or more years hence. The increase in annual value of oil and gas produced by 1980 at assumed 1960 price levels for full-scale production is estimated to be in excess of $400 million. Expenditures by the oil companies at that time should be of the same magnitude. Major future discoveries that may be made in favorable petroliferous regions in the Area could boost these future economic impacts very substantially. An increase in annual value of coal production amounting to $10 million is also deemed possible.

- Development of the Area's vast forest resources already well started, will proceed in 20 years to the full utilization of the sustained annual yield of the Alaskan Coastal Forest and substantial development of the forests of north-central British Columbia and northwestern Alberta. Pulp mills will consume the lion's share of this additional timber. By the end of the 20-year period the rise in value of forest products at 1960 price levels is estimated to be almost $300 million annually.

- Potentials for major new metal and mineral developments other than fuels depend largely on discovering larger and/or richer deposits than are now known to occur in the Area. Best chances for future commercial development of known occurrences involve many deposits on or reasonably close to the coast. Iron ore, copper, mercury, lead-zinc-silver, tungsten, asbestos, and limestone offer most promise for developments from known deposits in 5 to 20 years. The Area is considered good "hunting ground" for metals and minerals. The annual value of metals and minerals produced at 1960 prices may increase between 1960 and 1980 by about $180 million. High costs are a serious obstacle to future developments, especially in Alaska.

- Assuming the fishing industry conforms with state conservation programs, the Alaska long-range state salmon rehabilitation program is effectuated, and effective international agreements are worked out and adhered to, the average fish catch will rise substantially above recent low levels. Increase in annual value of the fish catch at 1960 prices during the next 20 years should be about $22 million by 1980.

- Additional agricultural produce needed to supply up to 25 per cent of the needs of Alaska's growing population can best be produced by more intensive cultivation and development of lands on or adjacent to roads now serving agricultural regions in the state. An annual increase in value of farm products amounting to about $55 million is believed to be attainable by 1980 from the entire Area.

- Foreseeable possible development of tourism, resources, and resource-based industries in the Area in 20 years may result in a total population increase of almost 338,000, an annual payroll increase by 1980 of about $350 million, and output of new products valued at over $1,400 million annually, but these include some highly conjectural developments, especially in metals and minerals. This also is exclusive of any major changes in military personnel and activities in the Area.

- The future energy-use picture in Northwest North America will be characterized by increasingly keen competition among the various energy sources - hydro, coal, gas, and oil, with nuclear sources perhaps becoming competitive in isolated locations a bit farther in the future. This competition is concerned at present with very limited local markets in the Area, and even a doubling or quadrupling of such local markets in the next 20 years will still amount to only relatively small demands. The Area contains tremendous undeveloped hydropower potentials, totalling some 30 million kilowatts rated as installed capacity, at least half of which is potentially low cost with full use of the output. Careful analyses of specific markets on a world wide basis might indicate opportunities for sequential development of these huge resources in competition with other low-cost hydro and thermal power potentials elsewhere in the world. Transmission of large amounts of hydro power from the Peace River region to areas of heavy power consumption to the south is quite possible within this time.

- Foreseeable natural-resource developments from presently known occurrences in the next 20 years in general will not require extensive land transport of freight over new or improved major roads or railroads. Substantial freighting that might result from new discoveries of minerals in interior regions will largely move most economically by shortest land route to the coast and thence by water to markets, rather than over long rail or highway routes to interior points in Canada and to the southern 48 states, or to markets on the Pacific periphery.

- Development of an improved and integrated highway system is needed to provide the travel comfort and flexibility needed for expansion of tourism in the Area. The system would comprise the following components:

  (1) The Alaska Highway and Route 5, Hazelton, B. C., to Jakes Corner, Y. T. Construction of new and relocation and upgrading of existing roads, where needed, and paving both routes.

  (2) Haines Cutoff. Relocation of section between Mile Post 23.3 and Goat Creek (Mile Post 76.5) along the "high" Kelsall River location to facilitate snow removal, making all-year travel more practical, and paving the road from Mile Post 23.3 to Haines Junction. These improvements would provide additional flexibility and all-year utilization in conjunction with the planned Southeastern Alaska ferry system.

  (3) Petersburg-Route 5 Highway. Construction of new road from Route 5 to Popof Creek, the eastern terminus of the planned State of Alaska road from Petersburg. This would provide flexibility to the traveler through visits to Petersburg, and to other points of interest by use of the planned Southeastern Alaska ferry system.

(4) Juneau-Route 5 Highway. Construction of a new road from a junction with Route 5 south of Atlin to Juneau. This would provide flexibility to the traveler through opportunity to visit Juneau and to utilize the planned Southeastern Alaska ferry system to the points either north or south.

- Broad features as to location and types of road and surfacing should be as described in Supplement I, prepared by Brown & Root, Inc. Flexibility in planning and designing of specific sections, however, should be encouraged to take advantages of features not immediately apparent in the reconnaissance-type survey made by Brown & Root for this study. In general, indicated maintenance costs for asphalt-surface-treated roads in the Area should be roughly similar to costs for gravel roads, a good average figure being about $2500 per mile annually. Specific sectors, however, could show a wide variation from the average over-all estimated maintenance costs.

- Use of asphalt-surface-treated rather than asphaltic concrete pavement is suggested because of the low travel density in the Area and substantially lower construction cost. However, test sections of various types should be included in any program in order to gain a better picture as to the type or types of road surface most economical to build and maintain over the long run.

- Cost-benefit comparisons of the integrated highway systems indicate that maintenance costs for the system would be more than recovered within each political division from potential additional gasoline tax revenues derived from interregional users of the system by 1980.

- Capital costs of constructing the system would be more than recovered through additional tax revenues obtainable through the expanded economic development within the Area made possible through the expenditures of interregional travelers while within the Area. These expenditures also would have a compounding effect on the Area, accelerating its economic growth potential. The estimated time for recovery of the capital costs involved in constructing the system at 5 per cent interest, including annual additional maintenance costs of $1.5 million, would be about 13 years.

- An expanded system of secondary development or pioneering roads is urgently needed for accelerated exploration of Alaska's potential metal and mineral resources.

- The provision of frequent marine transport facilities for passengers, autos, and trucks (ferry service) along the Inside Passage to connect existing road terminals at Prince Rupert, B. C., and Haines and Skagway, Alaska, is vitally important for the economic growth of the Area as a whole. It will constitute a "marine highway" link in a section where road construction is virtually impossible due to rough topography and heavily indented shore lines. Previous comprehensive studies of this system — not evaluated in this study — have presented details and predicted profitable operation, with which some authorities have disagreed.

- Extended and improved marine barge service for railroad cars, vans, and containers between ports in Alaska, British Columbia, and Pacific Northwest states should contribute to lower freight costs and result in economic benefits to the

Area. Modernized methods for transferring cargo from vessels to railroad cars or trucks will contribute importantly. Such extension and improvement of services of this type, already in use, is being studied and planned by numerous rail and barge companies.

- Without any implications as to its economic feasibility, the Pacific Northern Railway is considered in the category of a planned facility. Consideration of a Fairbanks-Whitehorse railroad, feeding freight to tidewater at Skagway via the White Pass & Yukon Route (possibly standard-gauged), gives an estimated cost of about $150 million and an annual operating subsidy of about $13 million, with maximum foreseeable annual freight movement of 300,000 tons for an average haul of 200 miles. Strict economies, joint operation with the PNR and Alaska Railroad, and low freight haul could reduce this figure substantially. The above assumes average freight revenue of 5 cents per ton mile, dictated by present competition of efficient trucking of minerals and supplies. Inclusion of indirect benefits, such as taxes from increased land values, would partially balance possible omission of amortization and interest charges under government operation. Highways, serving both moderate efficient freight movement by truck and tourist travel by auto, are considered a better transport facility than a pioneering railroad to present-day America for "opening up" a country having limited unproved resources.

- Uncertain as the immediate outlook may appear for many of the known resources and resource developments in the Area, the indomitable and venturesome spirit of the Area's optimistic, industrious, pioneering populace will help greatly in ultimately hurdling obstacles lying in the way of full realization of the Area's promising economic potentials.

- It is vitally important that highly visionary views and concepts be mixed with a healthy amount of realism in charting the future economic development of the Area, and it is encouraging to note an increasing recognition of this on the part of more and more civic and business leaders in the Area.

Recommendations

Since the responsibilities of Battelle to the Alaska International Rail and Highway Commission are concerned only with the need for new or improved transportation means designed to encourage the rapid economic development of resources in Northwest North America, recommendations are limited to this field. Nothing has been included with respect to (1) action needed or desirable to encourage more accelerated resource development unless related to transport facilities, or (2) strategic or tactical military needs related to transportation to or within the Area.

- Since the Commission is a United States agency dealing with international matters involving Canadian interests, Battelle recommends that the Commission respectfully request the United States Government to initiate with Canada through proper diplomatic channels the implementation of a program to construct an integrated highway system designed to encourage the rapid expansion in numbers of travelers visiting Northwest North America.

The recommended integrated highway system comprises the following components:

(1) The Alaska Highway. Upgrading by necessary relocations, line improvements, and bridge replacements and asphalt-surface treating from north of Charlie Lake, B. C., to the Alaska border, and

Route 5-Hazelton, B. C., to Jakes Corner, Y. T. Construction of an asphalt-surface-treated road from Hazelton to Jakes Corner, using about 282 miles of the Stewart-Cassiar Road, Telegraph Creek Road, and the road from Atlin to Jakes Corner.

(2) Haines Cutoff. Relocation and shortening of the portion of the Haines Cutoff between Mile Post 23.3 and Goat Creek (Mile Post 76.5) along the "high" Kelsall River location to facilitate snow removal, making all-year travel more practical, and upgrading and asphalt-surface treating of the entire road from Mile Post 23.3 to Haines Junction.

(3) Petersburg-Route 5 Highway. Construction of a new asphalt-surface treated highway from a junction with Route 5 down the Iskut and Stikine Rivers to Popof Creek, the eastern terminus of the planned State of Alaska Highway from Petersburg.

(4) Juneau-Route 5 Highway. Construction of a new road from a junction with Route 5 south of Atlin to Juneau, Alaska. The portion from the junction to the Alaska border should be asphalt surface treated. The remaining section to Juneau should also be paved when the Alaska State Government makes a final decision regarding best location for the road.

- Alaska and appropriate Canadian agencies are urged to develop a planned, integrated program to encourage travelers to the Region. This would involve a considered assessment of the attractions within the Region, planning for and encouragement of the development of desired facilities to meet the travelers' wants and needs, and stimulating travel to and within the Region through coordinated promotional activities.

II. INTRODUCTION

Historic Background

Ever since the excitement of the Klondike gold rush first focused attention on the potential wealth of Northwest North America at the turn of the century, interest has turned periodically to consideration of providing rail or highway linkage between the U. S. and the then Territory of Alaska. Subsequent major development of gold, copper, and lead-zinc-silver mining in Alaska, Yukon Territory, and northern British Columbia in the early decades of the 20th century confirmed the popular belief that this area was potentially rich in mineral resources. Varied degrees of development of other resources, including fish, forests, and furs, added to the modest economic growth of the region during this period.

Interest in the need for a land-transportation connection was evidenced in creation of Commissions by the U. S. Government in 1930 and 1938 to study location and feasibility of such a linkage by highway, with reports having been issued by these Commissions in 1933 and 1940, respectively. Studies concerning the feasibility, location, and cost of a railway connection were made by the U. S. Army Corps of Engineers in 1942 and by a Joint Committee of U. S. Government Departments set up in 1950 by an Act of Congress in 1949.

Meanwhile, action of the Japanese in occupying parts of the Aleutian Island chain in early stages of World War II focused attention on the critical importance of Alaska in the U. S. defense pattern, together with the vital need for land-transport linkage of Alaska with the U. S. Following a decision of the Joint Board for Defense in February, 1942, the Alaska Highway was built in less than a year, using none of the routes recommended in the 1933 or 1940 reports. This defense project followed a system of airfields strung along a route surveyed in 1935 by the Canadian Department of Transport and chosen as the most practicable flying route to the Yukon.

Virtually all of these earlier studies of highway or railroad linkages with Alaska stressed preferred locations and engineering feasibility and cost, with relatively minor attention given to economic need or feasibility.

One major study, not yet mentioned, did consider broader problems of mutual interest to Canada and the U. S. in the economic development of northwestern North America. This was the North Pacific Planning Project, undertaken in 1943 by Joint Economic Committees organized by Canada and the U. S. Much attention was given to evaluating the natural resources of the huge area under these studies (larger than that herein included), and the reports issued by these Committees have been helpful in the present study. By and large, however, descriptions of resources were too general to be of major assistance.

Realizing the need for a thorough and complete study that would assess the economic and military advantages of additional highway and rail linkages between the U. S. and Alaska, the 84th Congress passed Public Law 884 in 1956 establishing the Alaska International Rail and Highway Commission and describing its duties. The Commission decided at an early date to contract with a non-Government organization for the economic phases of the study. Invitations for proposals were issued by the Commission and a substantial number were received and considered. Delays in obtaining needed appropriations from Congress postponed final choice and award of the contract to Battelle Memorial Institute until July, 1959. Consideration of strategic military factors related to needs for improved or new transport facilities was excluded from the Battelle study.

Objective and Scope

The study undertaken by Battelle was aimed at developing and evaluating data bearing on the following ten points specified by the Commission:

(1) Capabilities and economics of existing and planned transport facilities between Alaska and the U. S. and anticipated improvements thereon between now and 1980.

(2) Location, availability, and volume of resources whose economic exploitation is dependent upon improved or additional transportation facilities between the U. S. and Alaska, and the intervening areas.

(3) Present and prospective location of local, national, and/or world markets for such resources and present and long-range (1980) competitive position of each.

(4) Delivered cost of marketable resources utilizing existing transportation facilities and subsequent comparison with estimated costs, utilizing proposed additional or improved transportation facilities.

(5) Increase in national income and population resulting from production, processing, and shipment of additional raw and/or finished products to national or world markets.

(6) Traffic and transportation revenues and taxes generated from the foregoing.

(7) Most feasible and direct major and feeder routes for rail and/or additional highway facilities in relation to economic benefits to be derived therefrom by the U. S., Canada, and Alaska, taking into consideration the proximity to such routes of suitable sites for airfields.

(8) Estimated construction costs of additional major and feeder routes based on aerial photos now available from U. S. and Canadian sources, supplemented by such route surveys as may be available.

(9) Economic feasibility of improved or additional transportation facilities from correlated cost and revenue estimates, considering the economic effect on present carriers. If not economically feasible, form and extent of subsidy or assistance required.

(10) Prospects for private capital investment in the transport facilities being considered.

It was further specified by the Commission that:

"In performing its responsibilities under this contract, Battelle shall place emphasis on the determination of the location, availability, and extent of undeveloped natural resources in Northwest North America, the exploitation of which is dependent upon additional transportation facilities; and Battelle shall make a forecast of the market demands and competitive position of each of these resources in world markets during the next 20 years. Battelle shall take into account the role of technology as it may affect the development or substitution of materials or products. The volume and location of these marketable products and the cost of construction and operation of proposed transportation facilities shall provide a cost-benefit ratio, and such ratio shall provide a basis for conclusions and recommendations to be made by Battelle to the Commission."

"Battelle shall study, analyze, and appraise the economic development potential of Northwest North America as it is related to additional main and feeder transportation needs between Alaska and the other forty-eight States, and shall determine the economic benefits to be derived by Alaska, the other forty-eight States, and Canada."

The above aims and objectives as outlined by the Commission have served as guideposts throughout the study. However, because of the vast scope of subject matter and land area involved, Battelle has minimized or even omitted consideration of many of the above factors relating to many different specific resources of minor importance, concentrating its efforts on those features that in Battelle's judgment were of major importance. In so doing, Battelle has followed the Commission's instruction to "schedule its time, efforts, and resources as related to the several phases of the study in proportion to their respective degrees of importance to the whole study so as to enable Battelle to arrive at definite conclusions and recommendations in its final report to the Commission."

At a relatively early stage in the study it became apparent that many resources, of vital importance to the future economic growth of the Area, are <u>known</u> to exist in such small amounts or are of such submarginal grade, that any <u>major</u> developments in the future will be contingent on <u>discovery</u> of major resources in the future. With the agreement of the Commission, Battelle has endeavored to keep its study strictly objective and based largely on facts as best determined up to the present. In other words, there has been no attempt to base future transportation needs on projections of resource discoveries obtained by any elaborate probability formulas. Efforts to project marketability of resources 20 years into the future, however, involve many assumptions and much conjecture concerning world economics and politics that have vital bearing on demand, supply, and price of the many resources covered. In these projections major reliance has been placed on previous long-range estimates on resource demands made by Government groups or by industry spokesmen, tempered by Battelle's judgment on effects of trends since these estimates were made together with subsequent and foreseeable technologic trends affecting future demands for the resources. The comprehensive reports of the U. S. Paley Commission and Canada's Gordon Commission were especially useful in this respect.

Although initial plans included consideration of needs for and benefits from not only major transportation linkage between Alaska and the other 48 states but local feeder and development roads as well, these were later modified by the Commission whereby major stress was to be placed only on recommendations relating to new or improved Alaska-48 states linkage routes and important feeders to such major linkage routes. Comments concerning desirability of other improved transportation facilities for consideration of Government transportation planning groups were to be mentioned where appropriate, without detailed location and costing studies that would be needed for specific recommendations.

Geographic Limits of Area

In early discussions with the Commission, specific boundaries of the area to be included in Northwest North America, under study, were decided upon. This was to include (1) all of Alaska, except the Alaska Peninsula and the Aleutian Islands; (2) all of Yukon Territory; (3) a narrow strip of Northwest Territories as far east as the Mackenzie River southward to 120°W longitude, thence southeastward by straight line to the intersection of 115°W longitude and 60°N latitude; (4) the northwest quarter of Alberta, bounded on the east by 115°W longitude southward to Lesser Slave Lake, thence southwestward by straight line to Prince George, British Columbia; and (5) roughly the north half of British Columbia, lying north of the Canadian National Railroad between Prince George and Prince Rupert. It comprises a vast area of some 1,150,000 square miles pictured in Figure III-1 and many subsequent base maps in the report. This southerly limit was chosen because of the general paucity of rail and highway facilities down this far, except for the local network up to and around the Peace River of British Columbia and Alberta.

In much of the text of the report this region is referred to as the Area (capitalized) to avoid frequent repetition of the term of Northwest North America.

Study Methods

In tackling a study of such comprehensive scope over such a huge area, it was necessary to depend heavily on previous studies that have summarized the various factors (resources, transportation, economics, etc.) for major portions of the Area. It would be far beyond the limits of time and budget to piece such a picture together from hundreds or thousands of specific published references on highly localized matters. Where important, however, many such localized reports were studied during the project. Numerous trips were made by the Battelle staff into the Area at early stages of the study to obtain present data and leads on preferred information sources, and the extensive file of reports, memoranda, maps, etc., in the Commission's library was turned over to Battelle.

Subsequently more recent data were obtained by Battelle by extensive letter communication and travel, during the course of which contacts were made with literally hundreds of experts in state, provincial, federal, and dominion governments, in commerce, and in industry – located both in the Area and in other parts of the United States and Canada. Many of these organizations and individuals were also very helpful in reviewing and commenting on the results of the study.

Cooperation

Generally speaking, the cooperation of all the agencies, companies, and individuals from whom information and assistance were sought has been superb, recognizing, of course, that certain highly confidential data on most recent developments could not be revealed. This fine cooperation of all persons and parties concerned is gratefully acknowledged. A listing of most of these organizations is given in Appendix B.

Recognizing the danger of singling out specific names for acknowledgment of special assistance, it is felt that Battelle would be remiss if this were not done in the case of the following organizations: British Columbia Department of Highways; British Columbia Department of Industrial Development Trade and Commerce; U. S. Geological Survey; U. S. Forest Service; Canadian Department of Mines and Technical Surveys; and Northwest Highway Maintenance Establishment, Royal Canadian Engineers. Several of these participated in careful review of pertinent sections of the report and offered very helpful suggestions. Battelle is happy to acknowledge this special assistance, making it plain, however, that such review by these organizations does not imply official approval of the results.

On behalf of the Commission, Battelle staff members briefed various Government groups periodically concerning progress and tentative findings of the study, including officials in Alaska, British Columbia, Yukon Territory, Alberta, and the Dominion Government in Ottawa. Tentative findings were also discussed during May, 1960, with groups of citizens in ten communities in Alaska and Yukon Territory.

Work of studying the preferred location and estimated costs of various highway routes was subcontracted by Battelle to the engineering firm of Brown & Root, Inc., with headquarters in Houston, Texas. The excellence of their cooperation, with full-time assistance of their engineer, James H. Burch, for several months is acknowledged.

The undertaking at Battelle was divided among a team of specialists in the various resources, mainly from Battelle's Department of Economics, as follows: metals and minerals, except fuels, Dr. Richard J. Lund; oil and gas, David D. Moore; coal and hydro power, Dr. Harlan W. Nelson; forests and forest products, Leonard M. Guss; fish and fur, Robert E. Holmes; agriculture, Konrad Biedermann and Dr. Odin Wilhelmy; tourism, James M. Jennings; economics, Dr. George W. James and Joseph W. Holcomb; transportation, Robert E. Holmes and James M. Jennings; and climate, geology, and water resources, Richard J. Anderson. Dr. Lund served as Project Coordinator with help from Messrs. Holmes and Jennings; A. C. Richardson was Battelle's technical director assigned to the project; and the Steering Committee at Battelle included several of the names cited above plus Dr. B. D. Thomas, president, John S. Crout, vice president, and Ralph A. Sherman, technical director.

Major assistance in planning and reviewing work on the project was received from Dr. George W. Rogers, economist in Juneau, Alaska, who served as consultant to Battelle throughout the study. Further helpful reviews and suggestions were received periodically from the Honorable B. Frank Heintzleman, regional forester and past governor of Alaska, and technical advisor to the Alaska Rail and Highway Commission, and from Edward W. Hassell, Office of the Under Secretary of Commerce for Transportation.

Finally, and most importantly, Battelle is happy to acknowledge the continued keen interest, helpful assistance, and pleasant liaison relations with Carl L. Junge, executive director of the Alaska International Rail and Highway Commission, throughout the project.

The study by Battelle covered the period from approximately August 1, 1959, through December 31, 1960, although the major portion was completed prior to submission of the preliminary report to the Commission on October 31, 1960. Attempts were made to include data available up to mid-1960, with references to some later developments included where important, such as consideration of the Pacific Northern Railway as a planned facility.

III. PHYSICAL FEATURES, GEOLOGY AND CLIMATE

Physical Geography

To prepare a complete and detailed treatise on the physical geography of Northwest North America is not the purpose of this study. However, the role which geography has played in the history and economic development of this huge area is certainly a major one and this role will be equally important in the future status of the Area. Without an understanding of its principal geographic features, no one can fully appreciate the problems of the past or properly evaluate the future of Northwest North America. Our purpose in this section, then, shall be to sketch the principal features as briefly as possible. Major physiographic provinces of the Area are sketched on Figure III-1. For those who wish to examine the Area in greater detail, a list of references of the principal published works on this subject is to be found at the end of this chapter.

The principal geographic features to be discussed here are:

The Coast

The Mountain Systems

The Gateways

The Coast

British Columbia to Cook Inlet. The great arc described by the coastline of Northwest North America, from northern British Columbia to Cook Inlet, has one principal characteristic throughout its length – steep mountain slopes rising directly from the sea. This formidable edge of the continent is often strikingly picturesque, but one must bear in mind that the same features which contribute to its scenic quality also present natural barriers to communications, and have handicapped the development of the hinterland.

In the highest regions, the mountain tops are covered by ice fields. In some areas these ice fields are the source of large valley glaciers, long rivers of ice which often reach the sea. These glaciers were once far greater in length than they are today, and the sea has now invaded the valleys which yesterday were occupied by ice. Thus, the coast has numerous steep-walled fiords, where the water is often deep enough to permit the entry of ocean steamers. The invasion of the sea between the mountains, whose upper portions now appear as promontories reaching far out into the ocean, produces a "drowned" appearance which is the "trademark" of the coast of the Gulf of Alaska.

The great majority of the valleys that empty along the coast provide no access to the interior. A few large rivers have their headwaters in the interior: the Skeena, Nass, Unuk, Stikine, Taku, and Copper. The valleys of these rivers have been used as pathways through the Coast Mountains. Cook Inlet and Prince William Sound are major indentations and provide access to the heart of southern Alaska.

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Cook Inlet to Point Hope. West of Cook Inlet the long Alaska Peninsula reaches out to 163° west longitude, actually farther to the west than the Hawaiian Islands. Rugged terrain marks the coastline of the peninsula, with volcanic peaks making up the core of the highest ground. This volcanic zone continues westward to form the Aleutian Islands.

From Bristol Bay, on the north side of the Alaska Peninsula, the coast changes. Large rivers such as the Nushagak, the Kuskokwim, and the Yukon, have built deltas into the Bering Sea. Shallow water marks the approach to the land, and the mountain areas are subdued, low ranges, in contrast to the sharp snow-covered peaks to the southeast.

The western coast of Alaska is indented by two great bays, separated by the Seward Peninsula – Norton Sound on the south and Kotzebue Sound on the north. The western tip of the Seward Peninsula, Cape Prince of Wales, is only 52 miles from the easternmost point of land of the U.S.S.R., Cape Dezhnev, just across Bering Strait.

Point Hope to the Mackenzie River. The east-west mountain systems of northern Alaska terminate at Point Hope, on the Arctic Ocean. From this point eastward, the topography is soon reduced to the nearly featureless monotony of the Arctic Slope, and the marshy tundra of the Coastal Plain. In winter, the frozen land merges with the frozen surface of the Arctic Ocean. In midsummer, open water may separate the land from the southern limit of pack ice.

Lakes are numerous on the Coastal Plain near Point Barrow. "In many places huge areas contain far more water than land".[1]

All of Alaska, north of the Brooks Range, and all of the Arctic coast of Yukon Territory lie within the permafrost zone. "A common surface expression of permafrost is polygonal ground",[1] a phenomenon characterized by great polygons of tundra, separated by water or ice-filled trenchlike depressions.

The Mountain Systems

A complete discourse of the mountain systems of Alaska, British Columbia, and the Yukon Territory could, and very often does, resolve itself into a bewildering narrative of ranges, peaks, divides, and more ranges. Much of Northwest North America is mountainous. The principal mountain systems have a profound effect on the life of the Area, and no transportation plan can fail to take them into account.

The Coast Mountains. The Coast Mountains constitute the first, and possibly the most important barrier to easy communication with the interior.

Southeastern Alaska, and the adjacent portions of British Columbia, present a mountainous face to the Pacific Ocean. This is the western side of the Coast Mountains, a continuous mountain system which extends northward from Washington State along the west coast of British Columbia, through Southeastern Alaska, and finally ending in the Kenai Peninsula.

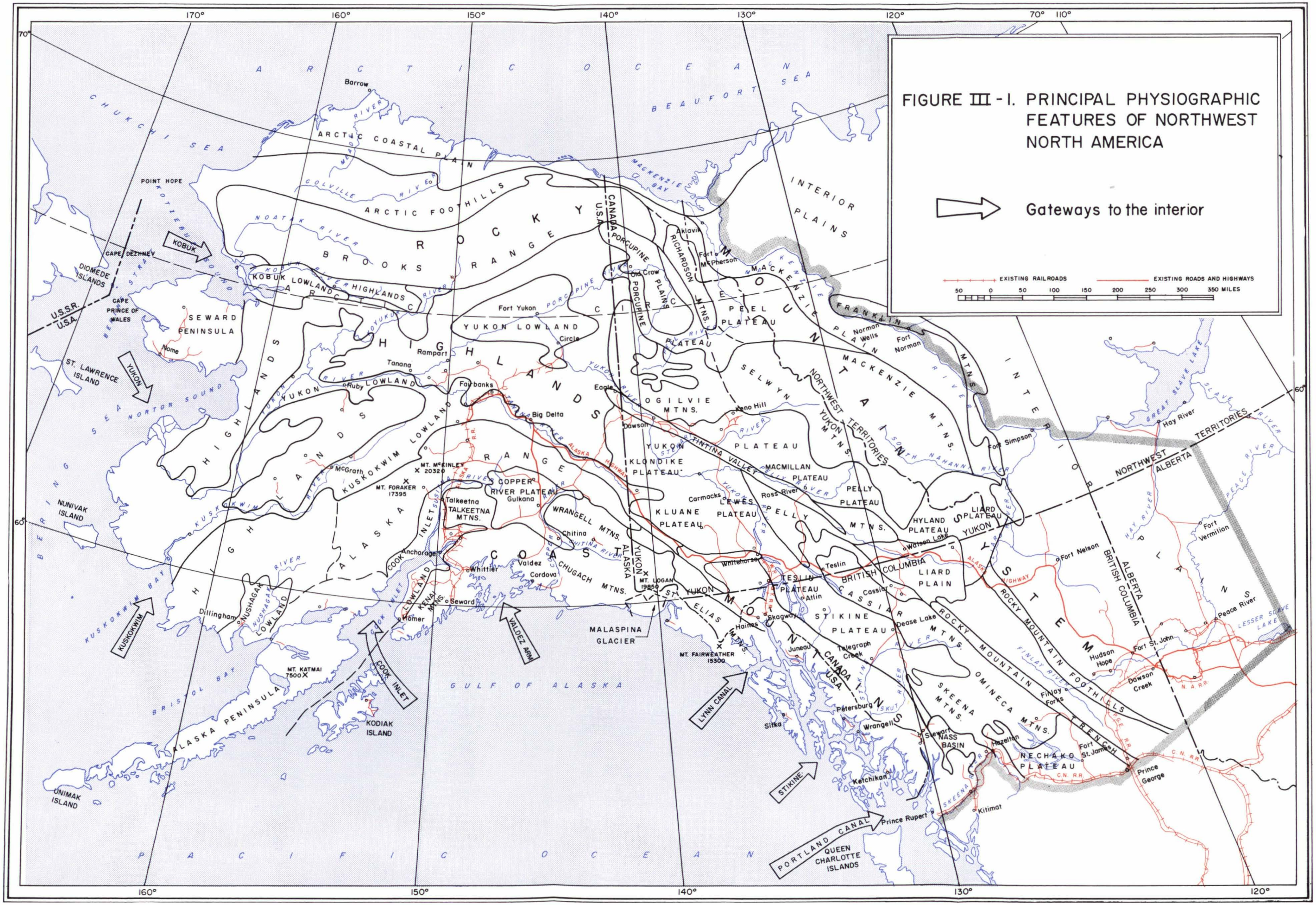
FIGURE III - I. PRINCIPAL PHYSIOGRAPHIC FEATURES OF NORTHWEST NORTH AMERICA
Gateways to the interior
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
NORTON SOUND
BRISTOL BAY
KUSKOKWIM BAY
GULF OF ALASKA
PACIFIC OCEAN
ARCTIC COASTAL PLAIN
ARCTIC FOOTHILLS
ROCKY MOUNTAIN SYSTEM
BROOKS RANGE
INTERIOR PLAINS
INTERIOR HIGHLANDS
PACIFIC MOUNTAIN SYSTEM
YUKON LOWLAND
KOBUK LOWLAND
HIGHLANDS
KUSKOKWIM LOWLAND
ALASKA RANGE
COPPER RIVER PLATEAU
TALKEETNA MTNS.
WRANGELL MTNS.
CHUGACH MTNS.
ST. ELIAS MTNS.
KENAI MTNS.
COOK INLET LOWLAND
NUSHAGAK LOWLAND
ALASKA PENINSULA
SEWARD PENINSULA
OGILVIE MTNS.
YUKON PLATEAU
KLONDIKE PLATEAU
KLUANE PLATEAU
LEWES PLATEAU
MACMILLAN PLATEAU
PELLY PLATEAU
PELLY MTNS.
TESLIN PLATEAU
STIKINE PLATEAU
CASSIAR MTNS.
HYLAND PLATEAU
LIARD PLATEAU
LIARD PLAIN
PEEL PLATEAU
PORCUPINE PLATEAU
PORCUPINE PLAINS
RICHARDSON MTNS.
SELWYN MTNS.
MACKENZIE MTNS.
FRANKLIN MTNS.
MACKENZIE PLAIN
TINTINA VALLEY
ROCKY MOUNTAIN FOOTHILLS
ROCKY MOUNTAIN TRENCH
OMINECA MTNS.
SKEENA MTNS.
NASS BASIN
NECHAKO PLATEAU
MALASPINA GLACIER
MT. McKINLEY 20320
MT. FORAKER 17395
MT. LOGAN 19850
MT. FAIRWEATHER 15300
MT. KATMAI 7500
KOBUK
YUKON
KUSKOKWIM
COOK INLET
VALDEZ ARM
LYNN CANAL
STIKINE
PORTLAND CANAL
U.S.S.R. U.S.A.
CANADA U.S.A.
ALASKA YUKON
YUKON BRITISH COLUMBIA
NORTHWEST TERRITORIES
ALBERTA BRITISH COLUMBIA
Barrow
Point Hope
Cape Dezhnev
Diomede Islands
Cape Prince of Wales
Nome
St. Lawrence Island
Nunivak Island
Unimak Island
Kodiak Island
Queen Charlotte Islands
Fort Yukon
Circle
Rampart
Tanana
Ruby
Fairbanks
Big Delta
McGrath
Talkeetna
Gulkana
Chitina
Anchorage
Whittier
Valdez
Cordova
Seward
Homer
Dillingham
Eagle
Dawson
Keno Hill
Old Crow
Aklavik
Fort McPherson
Norman Wells
Fort Norman
Fort Simpson
Hay River
Carmacks
Ross River
Whitehorse
Watson Lake
Teslin
Atlin
Cassiar
Haines
Skagway
Juneau
Telegraph Creek
Dease Lake
Petersburg
Sitka
Wrangell
Stewart
Hazelton
Ketchikan
Prince Rupert
Kitimat
Fort St. James
Prince George
Finlay Forks
Hudson Hope
Fort St. John
Dawson Creek
Fort Nelson
Fort Vermilion
Peace River
Colville River
Noatak River
Kobuk River
Yukon River
Porcupine River
Kuskokwim River
Copper River
Mackenzie River
Liard River
Peace River
Finlay River
Skeena River
Great Slave Lake
Lesser Slave Lake
Alaska Highway

The Coast Mountains in British Columbia have a dominant northwest-southeast trend, and most of the mountain ridges follow this general direction. Thus, the inter-mountain valleys also trend northwesterly, and only where the major rivers have cut across these northwesterly ranges can an east-west opening be found.

The mountains are not of uniform height. Along the coast, even the tops of the less prominent hills are covered by trees. As the interior is approached, the mountains rise in elevation, and the tree line drops below the bare rock summits. Peaks over 12,000 feet are common. Mount Fairweather, northwest of Juneau, rises to 15,300 feet. In the highest area of the Coast Mountains, permanent ice fields are found, and from these vast accumulations of ice and snow come some of the great valley glaciers for which the area is famous.

The High Plateaus. Lying just to the east of the Coast Mountains, and separating them from the Canadian and Alaskan equivalent of the Rocky Mountains, are the High Plateaus. Actually, these High Plateaus are not flat, featureless areas, but are themselves mountainous, with an irregular and often indefinite outline. Various names have been applied to these plateaus. In British Columbia and Yukon Territory, the Nechako, Stikine, and Yukon Plateaus fall in this province. In Alaska, the Interior Highlands are similarly situated.

The High Plateaus range from less than 4,000 to more than 6,500 feet in elevation. They are often treeless, except in the stream valleys and in sheltered depressions.

The Rocky Mountain System. The familiar Rockies of Colorado and Wyoming extend up into Canada, across British Columbia, across Yukon Territory, and terminate in Alaska. In the area under study, the Rocky Mountains are separated from the High Plateaus by a remarkable physiographic feature, the Rocky Mountain Trench. "Beginning south of the Forty-Ninth Parallel and reaching to the Liard Plain where it disappears, the trench has a length of more than 900 miles and it is the largest valley feature of the Cordillera".(2)

A similar trench, the Tintina Valley, picks up the same boundary function beyond the northern end of the Rocky Mountain trench and extends northwestward into Alaska.

The British Columbia Rocky Mountains become the Selwyn Mountains of the eastern Yukon Territory. The system continues northwestward to include the Richardson Mountains of the northern Yukon Territory, thence turning westward and finally terminating in the Brooks Range of northern Alaska.

"The Brooks Range forms a great wall across northern Alaska... The loftiest general area is near the 144th meridian, not far west of the Yukon-Alaska border; here Mounts Chamberlin and Michelson rise probably to between 9,000 and 10,000 feet".(1)

The Alaska Range. The dominant physiographic feature of south-central Alaska is the mighty Alaska Range. This arclike mountain system merges into the Coast Mountains at its eastern end, and at its western extremity it serves as the "backbone" of the Alaska Peninsula.

The Alaska Range is approximately 600 miles long and 120 miles wide at its widest point. It contains a number of famous peaks, including the highest mountain in North America -- Mount McKinley, 20,320 feet high. The highest portions of this Range, like the great peaks of the Coast Mountains, are snow covered throughout the year. Here, too, large glaciers begin their long trip to the lowlands to the south.

Despite its rugged character, the Alaska Range can be crossed by following the valleys of the major rivers: the Nenana, Delta, Nebesna, Chisana, and White Rivers, and Beaver Creek. "Several of these provide routes of travel across the mountains. The Alaska Railroad follows the Nenana and the Richardson Highway follows the Delta".(3)

The Gateways

The earliest exploration of Northwest North America was accomplished by ship, first along the Pacific Coast, and later northwest into the Bering Sea and the Arctic Ocean. Penetration of the Area from the interior plains was not to come until many years later.

To the coastal traveler, few gateways to the interior present themselves. The great rivers which empty into the Pacific Ocean, the Bering Sea, and the Arctic Ocean are certainly the most obvious paths into the Continent. Thus, in the early 1900's, over half a century ago, "stern wheelers" churned their way along sections of the Yukon River as far upstream as Whitehorse. The Mackenzie and the Stikine have both seen active days of steamer traffic. Today, the river systems are comparatively unused as avenues of communication, despite the fact that there have been significant improvements in tow-boat construction, and despite the fact that waterborne freight along the inland waterways of the U. S. has experienced a huge growth in the past quarter century.

The long glacial fiords of the British Columbia and Southeastern Alaska coast provide access through part of the Coast Mountains, although seldom do these valleys continue inland for any great distance. One of the most famous of these remarkable, sea-filled trenches is the Portland Canal, which extends nearly 100 miles from Chatham Sound to Stewart, B. C.

The canyon of the Stikine River is one of the few major paths through the Coast Mountains. The river is passable to small vessels as far as Telegraph Creek in British Columbia, and a hunting and sight-seeing service operates from Wrangell, Alaska. The channel of the Stikine is subject to constant change, as great volumes of glacial silt tend to choke up the river courses; and flood water seeks new paths across the valley floor.

The Lynn Canal provided a pathway to the gold hunters of the 1900's, who portaged up over the Coast Mountains at Skagway and Dyea, and today is the marine end of the Haines Cutoff highway.

The Valdez Arm of Prince William Sound provides access to a pass through the Chugach Mountains, now followed by the Richardson Highway.

Physiographically, Cook Inlet constitutes a significant gateway to the interior of Alaska. Here, two major rivers -- the Susitna and the Matanuska -- can be followed upstream deep into the interior. Here there is abundant "flat" country, suitable for agriculture, and perhaps even more valuable, adequate ground for streets and homes.

The valleys of the Nushagak and the Kuskokwim provide access to southwestern Alaska. The Kobuk River reaches far into the southern foothills of the Brooks Range.

Geologic Features

The size of this corner of the continent, over a million square miles, can constitute a handicap to anyone who would see the surface of it, much less describe it. The geologist is not only interested in the surface of the earth, but in the subsurface as well. All of this vast area has been subjected to geological reconnaissance during the 60 years since 1900. Information supplied by ground parties has been supplemented by skilled interpretation of aerial photographs, and the combined efforts have produced numerous reports illustrating small-scale geologic maps of Alaska, British Columbia, Yukon Territory, and adjacent areas. Much of this work has been carried out by government agencies – state, provincial, and U.S. and Canadian federal bureaus.

Detailed geologic reports on specific areas, such as mining districts, are available in many cases for those interested in learning more of the geology than is described in the more generalized reports.

No attempt has been made by Battelle to duplicate here any extensive restatement of the regional geology of the area under study. The section which follows here can best be described as devoted to pertinent comments on the geology, having a direct or closely related bearing on the purpose of the study.

Rock Types

A wide variety of rocks is present in this area; in fact, one would be hard pressed to name a rock type which is not represented here.

The high mountains of Alaska owe much of their eminence to massive, weather-resistant granite. Mt. McKinley, Mt. Hunter and Mt. Foraker, in the Alaska Range, are granite peaks. In British Columbia, "approximately nine-tenths of the Pacific Ranges is carved from the granitic rocks of the Coast Range batholith"(2). Flanking the batholith on the east and west are areas of highly metamorphosed schists, slates, and gneisses.

Northern British Columbia and Yukon Territory share similar geologic situations, ranging from the very old schists and quartzites of the Klondike district, to comparatively recent rocks of volcanic origin, such as basalt lava flows. In the eastern portions of the Area, where mountain-building activity has been less violent in nature during the geologic past, thousands upon thousands of feet of limestone, shale, sandstone, and conglomerate have been measured by geologic mapping parties.

The visitor to Southeastern Alaska may note the monotonous assemblage of slates, and similarly distorted layers of black to greenish gray rocks, which can be seen in Ketchikan, Petersburg, and Juneau. They are much altered sedimentary and volcanic rocks.

Along the Alaska Peninsula, volcanoes, both new and ancient, have been built by huge accumulations of volcanic debris.

Limestone is a cliff-forming rock in the Wrangell Mountains. Limestone, changed by time and geologic forces to marble, was quarried early in the twentieth century in Southeastern Alaska.

Recent Geologic History

Much of western North America is comparatively "young", geologically speaking. The mountain ranges along the coast are rugged and "new" in appearance, and some, judging from occasional earthquakes, are still being formed. Volcanic eruptions of Mt. Shishaldin and Mt. Katmai attest to the active nature of the Aleutian portion of the Pacific "ring of fire". These recent mountains have been further steepened and dissected by glacial ice, to complete the rugged landscape of the present day.

The type of glaciation which took place over much of the area under study is known as "valley glaciation", as distinguished from "continental glaciation", where the entire land surface is covered by an immense ice sheet. The latter tends to smooth over and subdue the landscape, while valley glaciers carve and sharpen the contours of the mountains.

Not all of the area under study has been glaciated. The valley of the Yukon River, from Ft. Selkirk in Yukon Territory, to the north of the river on Norton Sound, was not invaded by glacial ice. The small valley glaciers along the north slope of the Brooks Range rarely reached the foothills, and the Arctic Coastal Plain is, strangely enough, unglaciated.

Factors Affecting Geologic Exploration

Whenever the geologist attempts to study an area in detail, he is faced with the problem of finding rock exposures, from which he can piece together an intelligent picture of the subsurface. In Northwest North America, the forest cover, the presence of huge ice "blankets" such as the Malaspina Glacier and the frozen ground in the tundra areas, have slowed the rate of geologic mapping, and partly explain why substantial areas lack detailed interpretations.

These natural barriers were more severely felt in the years before World War II, when the airplane had not yet become a reliable form of transportation, and long traverses by boat and on foot were the only way of penetrating the isolated regions of the interior.

Following the end of hostilities, a new age of exploration began in Alaska and northern Canada. Recognizing the lack of adequate base maps, a program of aerial photography was initiated. These photographs, together with new ground control data, have formed the basis for new and highly accurate topographic maps, constructed by photogrammetric techniques.

The search for oil and other valuable mineral deposits was given a valuable new aid by the development of the air-borne magnetometer. This device, formerly used by ground parties on long, time-consuming traverses, may now be suspended on a cable from a low-flying aircraft. One crew in a plane can cover in a few days an area that might require several seasons of ground work under the old methods.

Other geophysical exploration methods have been refined and improved, and a combination of improved prospecting techniques, more accurate mapping, and more complete understanding of the regional geology together made possible the discovery of oil and natural gas on the Kenai Peninsula.

To the prospecting for deposits of the valuable metals, the helicopter has been the greatest single boom. In mountainous country, many valuable days and precious hours of good weather can be used up in climbing and packing in supplies. With the introduction of the versatile helicopter, new efficiencies in mineral exploration have been achieved.

The modern prospector then bears little resemblance to his predecessor of the turn of the century. The pack horse has been replaced by the airplane and the jeep. The gold pan is still in use, but is supplemented by the magnetometer, the geiger counter, and the scintillometer. Gold and silver are no longer the primary targets. Copper, nickel, lead and zinc, and the "newer" metals, such as thorium, uranium, zirconium, and beryllium, are now being sought. The modern prospector is better trained and better equipped than the sourdough of half a century ago. If the new search for mineral resources is not productive, it will not be because of lack of skill.

Climate

The area covered by this study includes three climate types: (1) Marine West Coast, (2) Subarctic, and (3) Tundra. This rather extreme variation in climate is not only horizontal but vertical, as well, due to the relatively short distance between sea level and some of the highest elevations in North America.

Marine West Coast Climate

The dense forest cover of the Alexander Archipelago of Southeastern Alaska reflect the high rainfall and mild temperatures of the Marine West Coast Climate. The harbors of Southeastern Alaska are free from ice throughout the winter, in sharp contrast to Duluth, Minnesota, far to the south, whose port facilities on Lake Superior are closed by ice from December to April each year.

Mean average January temperatures in Ketchikan are above freezing (35. 1 F), and are only slightly below freezing in Juneau (29. 5 F) and Cordova (25 F). Mean July temperatures for the same localities are: Ketchikan 58 F, Juneau 54. 7 F, and Cordova 53. 3 F.

The mild temperatures are produced by the proximity of the Alaska Current, which also accounts, in part, for the high rainfall along the coast. On-shore air, heavily laden with moisture picked up over the ocean, is forced to rise on reaching the coastal mountains, and lower temperatures encountered at higher altitudes produce condensation and rain. The highest annual rainfall total ever recorded for Southeastern Alaska was measured at Little Port Walter, on the west side of Baranof Island – 212 inches. Ketchikan regularly records in excess of 150 inches per year. The protection of an off-coast island or two is reflected in a drop in total annual rainfall. Thus, Juneau, partially protected from the ocean winds, though still on tidewater, has an annual precipitation of only 55. 94 inches. The mountains which rise above Juneau to the north and east, however, receive much greater amounts of rainfall; it increases considerably at elevations of only 1,000 or 2,000 feet above Juneau.

Precipitation occurs throughout the year in this area. The greatest rainfall usually occurs in September, October, and November, as shown in Figure III-2. May, June, and July have the least rainfall. In an average October, Ketchikan receives more rain (21.47 inches) than falls in Fairbanks in an average year (11.92 inches).

Along the coast, precipitation during the spring, summer, and fall is in the form of rain. At higher elevations and particularly in the high coastal mountain peaks, snow can be expected during any month of the year. Fantastic accumulations of snow have been reported at high elevations along the coast. Compaction of the snow in the high mountain areas is the first stage in the formation of glacial ice, and thus originate the great valley glaciers of southern and Southeastern Alaska, and northern British Columbia.

Subarctic Climate

The Subarctic Climate extends over the major portion of the land area covered by this report. In sharp contrast to the coast, interior Alaska, most of Yukon Territory, and adjacent portions of the Northwest Territories and British Columbia have great seasonal variation in temperature. Summer can be uncomfortably hot, while winter brings some of the lowest temperatures recorded anywhere in North America.

Maximum temperatures in the Interior (e.g., Fairbanks) "reach or exceed the 90° mark almost every summer"(4). The long hours of summer sunlight in addition to the warm temperatures, promote rapid growth of vegetation, if ample water supplies are available.

At the opposite end of the temperature scale, winter lows of the interior are also extreme, with -75 F having been recorded at Fort Yukon. "At Dawson, in the Yukon, the thermometer, on an average January night, falls to approximately -29° and rises to nearly - 16 during the warmest hours of the day."(5)

The Subarctic Climate of the interior differs from the coastal climate in another equally striking feature. The rainfall of the interior is much lower than that of the coast. In Yukon Territory, "The average precipitation is just slightly above 12 inches a year".(6) At Dawson the total is 12.5 inches. The dry winters render the low temperatures more tolerable to man.

Tundra Climate

Much of northern Alaska and the extreme northern part of Yukon Territory lie in the Tundra Climate. The boundary between the Tundra Climate and the Subarctic Climate is indistinct, and various students of climate place the boundary each according to his interpretation of the meager data available. Trewartha(5) includes most of the Seward Peninsula and the north slope of the Brooks Range in the Tundra Climate type.

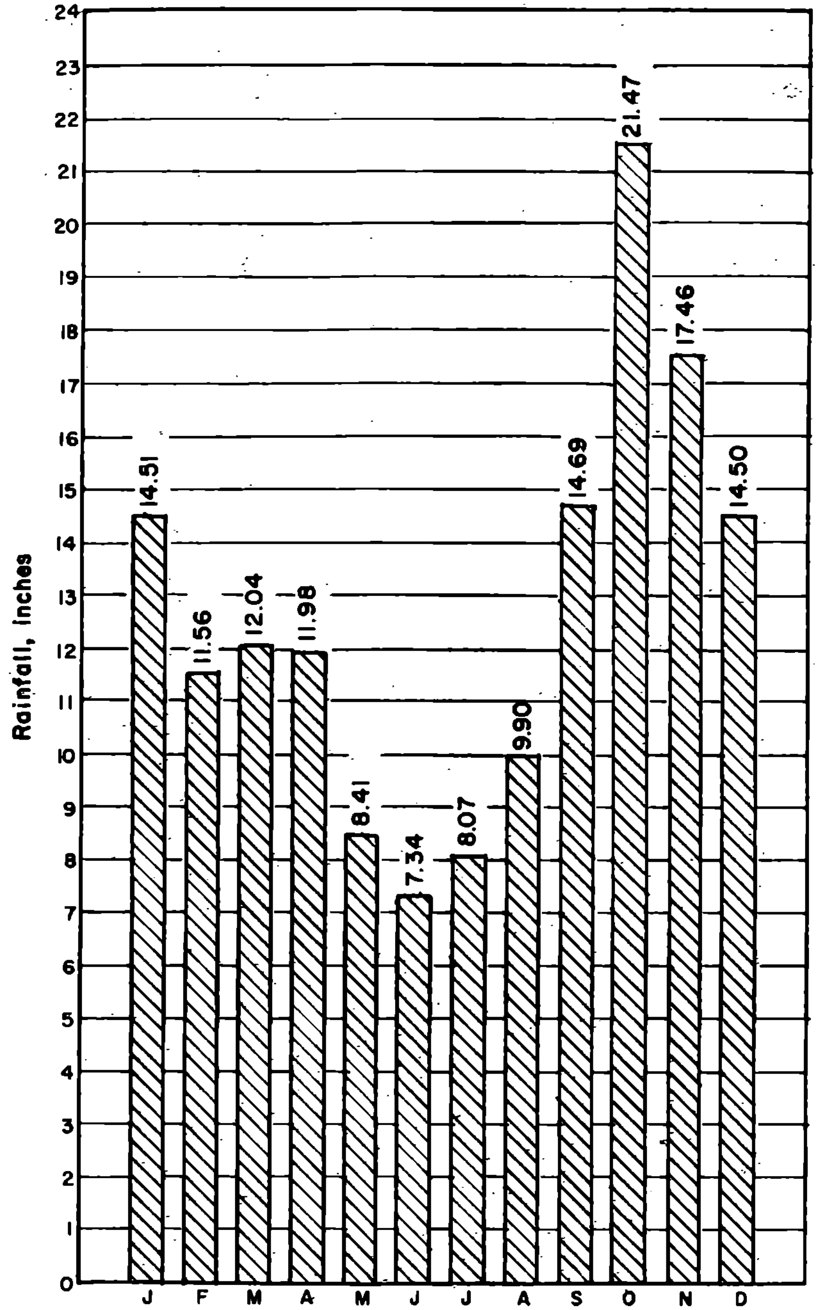

FIGURE III-2. AVERAGE MONTHLY RAINFALL AT KETCHIKAN, ALASKA, 1931-1955

Source: Watson, C. E., - Climate of Alaska, U.S. Weather Bureau, Washington (1959).

This is the "land of the midnight sun", where the sun remains generally above the horizon in the summer. Conversely, here the long Arctic night takes over in the winter. From late November until late January, the sun cannot be seen by the residents of Point Barrow, a "night" that lasts nearly 8 weeks.

Here, the proximity of the Bering Sea and the Arctic Ocean tend to lower summer temperatures and prevent winter lows from falling much below -50 F. The average January temperature at Nome is 3.4 F, while the July average is just under 50 F – not quite as warm in the summer, and not as cold in winter as the interior of Alaska.

Precipitation in the Tundra Climate area is usually quite low with annual totals ranging from less than 10 to about 20 inches. Point Barrow's annual precipitation is 4.11 inches while Kotzebue receives 8.03 inches and Nome gets 18.69 inches.

Along the coast and for short distances inland the Tundra Climate area is characterized by the formation of summer fog. Nome has fog an average of 67 days per year. Point Barrow is even worse with 82.6 average days of fog. This "Arctic smoke" presents a problem to airplanes and small boats not equipped with navigational aids such as radar. "Ice fog" offers similar visual blocks in the winter over land.

Climatic Change

The situation perhaps most evident to the student of Northwest North America is the limited extent of valley glaciers today, as compared to the tremendous ice rivers of the geologic past. "Glaciers are among the most sensitive climatic indicators in nature – annual variations in accumulations and ablation (loss of snow or ice, primarily by melting) and advances and retreats of the ice front, constitute keys to past and current climate trends."[7]

While conclusive evidence as to the reason has not yet been presented, it is apparent from preliminary work that most glaciers are retreating, with a few notable exceptions, such as the Taku glacier.[8] Such glacial retreat could be brought about by a reduction in precipitation or by a warming trend, or a little of both. Whatever the cause, the rate of change is so slow as to hold no particular promise to the inhabitants of Northwest North America in the near future.

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IV. THE PRESENT ECONOMY

Introduction

Any economic entity has the general objective of providing welfare for its population through effective utilization of its natural resources, skills of its labor force, and the entrepreneurship of its businessmen. Ideally, these objectives might be met by combining the natural resources and labor at a proper location with adequate management to meet domestic or foreign market needs. However, no matter how clear the objectives may be, meeting them is a continuing difficult problem. Depending on the state of development in which the economy finds itself, the answers to economic progress differ among countries or states. Thus, solutions for economic development of a basically primitive economy would differ significantly from solutions for continued development of a highly industrialized economy.

Alaska

Realistically, the State of Alaska is neither basically primitive in its economic development nor highly industrialized. It is at an indefinite point between these two extremes. That judgment can be made on the position of Alaska in this economic spectrum, it is necessary to look at the economic means possessed by the State. This can be done by a study of its population, natural resources, present manufacturing and supporting industry activity, and other economic functions within the State.

Population

According to The Bureau of the Census, the 1960 population of Alaska was 224,094, up 63.5 per cent from the 1950 population of 137,000. Comparison of these population figures might lead to the conclusion that there had been a steady and perhaps healthy growth in the population of the State. This is not the case. From the population data presented in Table IV-1 the following observations can be made:

(1) The military component of the Alaskan population has had, and continues to have, a significant influence on the total. During World War II, the military personnel in Alaska comprised 67 per cent of its total population. Even in 1958, the military still represented 18 per cent of the total population of the State. In addition, the number of civilians in Alaska associated with military activities constitutes a significant part of the total population.

(2) Since 1939 there has been only a minor growth in the native population.

TABLE IV-1. GENERAL POPULATION TRENDS IN ALASKA[a]

Year or Date	Native Population	Nonnative Population Civilian	Nonnative Population Military	Total Population
October 1, 1939	32,248	39,752	524	72,524
July 1, 1941	32,500	41,500	9,000	83,000
July 1, 1943	33,000	41,000	152,000	226,000
July 1, 1946	33,200	51,800	18,000	103,000
July 1, 1950	33,900	77,100	26,000	137,000
July 1, 1957	37,000	127,000	47,000	211,000
July 1, 1958	38,000	118,000	35,000	191,000
1960[b]	--	--	--	224,094

(a) Source: Rogers, George W., Arctic Institute of America. Paper presented at the Twelfth Resources Conference of the British Columbia Natural Resources Conference (November 20, 1959).
(b) Preliminary Bureau of the Census, U. S. Department of Commerce.

Other important factors concerned with the population of Alaska include the distribution of people within the State and its relative ranking with the other 49 states. Well over one-half of Alaska's population is found in the Anchorage and Fairbanks regions with those remaining distributed sparsely and widely throughout the State. Although geographically the largest state in the Union, Alaska possesses the least number of people, some 100,000 less than the State of Nevada.

Alaska comprises an essentially small market and one widely scattered over a large area. In addition, the vicissitudes of the military population in Alaska measurably affect the total population and present a frequently unstable local market.

If Alaska's population is viewed on a month-to-month basis throughout any one year, generally the total population is considerably larger in July than December due to the influx of migratory workers in the warmer months and their exodus by wintertime.

The Labor Force

Two striking observations can be made about the composition of the total labor force in Alaska. First, using monthly average employment data, slightly over 60 per cent of the total labor force is composed of military personnel and federal and local government workers. Second, another 25 per cent of the labor force is involved in "support" activities and individual self-employment, including wholesale and retail trade, transportation, utilities, and miscellaneous services. Thus, nearly 85 per cent of the entire labor force in Alaska may be termed "nonindustrial".

Table IV-2 presents 1957 data on monthly average employment by various primary and secondary industries in Alaska. To determine the level of employment by Alaskan industry, categories, shown under "Primary Industry" in Table IV-2*, except military, can be used. These industrial categories include construction, fishing, salmon canning, mining, hunting and trapping, lumber and wood products, pulp, printing and publishing, food processing, and other manufacturing. In 1957, the total employment in all of these industries was only 15.6 per cent of the total labor employment in the State. Of this industrial group, those employed in the construction industry totaled one-third of industrial employment. Excluding the construction industry, the apparent industrial base of Alaska employed only 10 per cent of the total labor force in the State.

TABLE IV-2. MONTHLY AVERAGE EMPLOYMENT IN ALASKA, 1957[(a)]

	Monthly Average Employment	Per Cent Total Employment
I. Primary Industry		
Military	47,000	42.7
Construction	5,863	5.3
Fishing	4,200	3.8
Salmon Canning	2,624	2.4
Mining	1,290	1.2
Hunting, Trapping	1,000	0.9
Lumber, Wood Products	696	0.6
Pulp	649	0.6
Printing and Publishing	299	0.3
Other Manufacturing	289	0.3
Food Processing (Excluding Salmon)	229	0.2
Total	64,139	58.2
II. Secondary Industry		
Federal Government	17,400	15.8
Trade and Services	11,954	10.9
Miscellaneous Self-Employed	8,600	7.8
Transportation and Utilities	5,079	4.6
Territorial and Local Government	3,000	2.7
Total	46,033	41.8
Total Employment:	110,172	100.0

(a) Source: Bloch, Ivan, "Alaska's Economic Outlook", The Analysts Journal (January-February, 1960). (Adapted from data of Alaska Employment Security Commission).

*Employment and wages as expressed in Tables IV-2 and IV-3 present a different picture from data shown in subsequent chapters, notably for such industries as fishing, salmon canning, construction, and lumbering. Apparent discrepancies arise from the methods of reporting by different governmental agencies – covered employment, average monthly or annual employment, total employment, etc. – for industries that have considerable seasonal employment fluctuation.

In 1957, quite a few of Alaska's industries, including lumber and wood products, pulp, printing and publishing, and food processing, employed less than 1,000 people. Significantly, the mining industry, a major activity in prior years, employed only 1,290 people in 1957.

Table IV-3 shows the distribution of covered wages paid to Alaskan industrial workers in fiscal 1958. Covered wages principally exclude wages paid to the military; the federal and local government employees; those in fishing, hunting, and trapping; and those self-employed. The total wage bill for Alaskan labor was $195.8 million in that year. Of this amount, the support industry complex (transportation, communications, and utilities; wholesale and retail trade; finance, insurance, and real estate; and other services) accounted for slightly over $94 million, and the wages paid to construction workers accounted for slightly over $60 million. Combining the wages paid to workers in the support complex and in construction, the total is nearly 80 per cent of all covered wages paid in the State in fiscal 1958. Manufacturing wages, paid to those employed in salmon canning, lumbering, and other manufacturing, accounted for only $31 million or about 16 per cent of the total covered wage bill.

TABLE IV-3. TOTAL WAGES PAID IN COVERED EMPLOYMENT BY MAJOR ALASKAN INDUSTRIES FOR FISCAL YEAR ENDING JUNE 30, 1958[a]

Industry		Wages, $000
Total		195,853
Agriculture and Forestry[b]		350
Mining		9,776
Contract Construction		60,474
General Construction, Building	25,868	
General Construction, Other	16,491	
Special Trade Construction	18,115	
Manufacturing		31,189
Salmon Canning	15,711	
Lumbering	4,006	
Other Manufacturing	11,472	
Transportation, Communication and Utilities		29,584
Wholesale and Retail Trade		37,611
Finance, Insurance, and Real Estate		6,210
Service		17,849
Not Elsewhere Classified		2,810

(a) Source: Alaska Department of Labor, Employment Security Division, Annual Report, FY 59.

(b) Includes a very small number of workers in the fishing industry. Fishermen now work on shares of the catch, rather than for reportable wages.

For the most part, those working in the construction industry are among the highest paid industrial workers in the State, followed by mining, communications and utilities workers, and manufacturing. Support personnel in wholesale and retail trade; finance, insurance, real estate; and other service activities are generally among the lowest paid workers in Alaska.

Seasonal employment is another important factor in the labor force of Alaska. For example, those employed in salmon canning during the summer months, principally May through September, may be 15 times the number employed in the winter months. In the construction industry, summer employment may exceed winter employment by a factor of four. Service industries generally show a more stable seasonal employment.

Natural Resources

Within the land and water confines of Alaska are found five major natural-resource-based industries which account for productive economic activity in the State. These are: mining, forestry, agriculture, fishing, and furs. Each of these major resources is studied in considerable detail in later chapters of this report. They are considered at this point only from the standpoint of their total value to the economy of Alaska and their interrelationships. Table IV-4 presents a historical picture of the total revenue of the five natural-resource-based industries in Alaska. Although the value of fishing activity leads the revenue realized by other resource-based industries, significantly no growth trend in fishing is evident over the last decade. The one resource-based industry in Alaska which has shown a healthy growth since 1950 is forest products, with a revenue of $27 million in 1958 compared with $4.4 million in 1950. Mining revenue has held fairly steady since 1952, the values being accounted for largely by gold, coal, sand and gravel, platinum, and mercury.

TABLE IV-4. REVENUE OF NATURAL-RESOURCE-BASED INDUSTRIES IN ALASKA, 1950-1958[a]

In thousands of dollars.

Industry	1950	1951	1952	1953	1954	1955	1956	1957	1958
Fisheries and Canning	100,156	95,916	88,534	69,671	77,879	69,723	92,960	79,472	83,742[b]
Forest Products	4,400	4,100	4,400	4,600	13,300	29,500	33,600	33,100	27,300
Mining	17,852	19,569	26,302	24,252	24,408	25,412	23,408	28,792	22,315
Agriculture	1,750	2,186	2,865	2,820	2,878	3,487	4,231	4,539	4,676
Furs	5,826	6,554	6,373	5,229	5,902	6,211	5,688	5,283	4,000

(a) Source: "Alaska – Its Economy and Market Potential", U.S. Department of Commerce (1959).
(b) "Alaska Fisheries", Bureau of Commercial Fishing (1958).

Although starting from a relatively small base of $1.7 million revenue in 1950, the agricultural industry grew about threefold by 1958 to a total value of $4.7 million. The annual revenue of the fur industry dropped from $5.8 million in 1950 to $4.0 million in 1958.

Manufacturing

The most prominent manufacturing industries in Alaska are those involved in fish canning and pulp manufacturing. Of the nearly 5,000 workers employed in manufacturing

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in Alaska in 1957, about 2,600 were in the salmon-canning industry. Pulp production has shown a strong growth, accounting for virtually the entire jump in forest products' value in Table IV-4. Another jump will be evident in 1960, with the second large mill getting into production. Other manufacturing activities include production of wearing apparel and leather goods.

The historical change in establishments, employees, and total wages for the manufacturing industries of Alaska are shown in Table IV-5.

TABLE IV-5. NUMBER OF MANUFACTURING ESTABLISHMENTS, EMPLOYEES, AND WAGES PAID FOR ALASKAN INDUSTRIES IN 1939, 1954, AND 1957[a]

Year	Number of Establishments	Number of Employees	Total Wages
1939	230	5,467	$ 6,883,988
1954	219	4,092	16,546,000
1957	323	4,772	32,949,000

(a) Source: "The Alaskan Market, 1958", J. Walter Thompson Company.

Supporting Industries

Supporting industries in Alaska are those which serve, in one form or another, the more basic functions of the economy. Industries classified as supporting industries would include wholesale and retail trade; finance, insurance, and real estate; transportation and communications; and miscellaneous services for such things as amusement, auto repair, haircuts, and similar functions.

In Alaska, the supporting industries may be viewed as those serving: (1) the natural-resource-based industries, which require considerably less service than would a broad manufacturing base, (2) the Alaskan exterior trade activity, which places most of the services – such as wholesale trade – near the seaports and the heaviest population centers, and (3) the military, which subjects the supporting industries to frequent fluctuations.

Wholesale and Retail Trade. Table IV-6 presents a comparison of wholesale activity in Alaska for the years 1948 and 1954. Data for wholesale trade in 1958 will soon be published by the U. S. Department of Commerce.

In terms of number of establishments and value of sales, the wholesale activity in Alaska has grown substantially over the last decade. The total number of establishments involved in wholesaling grew from 111 in 1948 to 184 in 1954. The number of wholesale

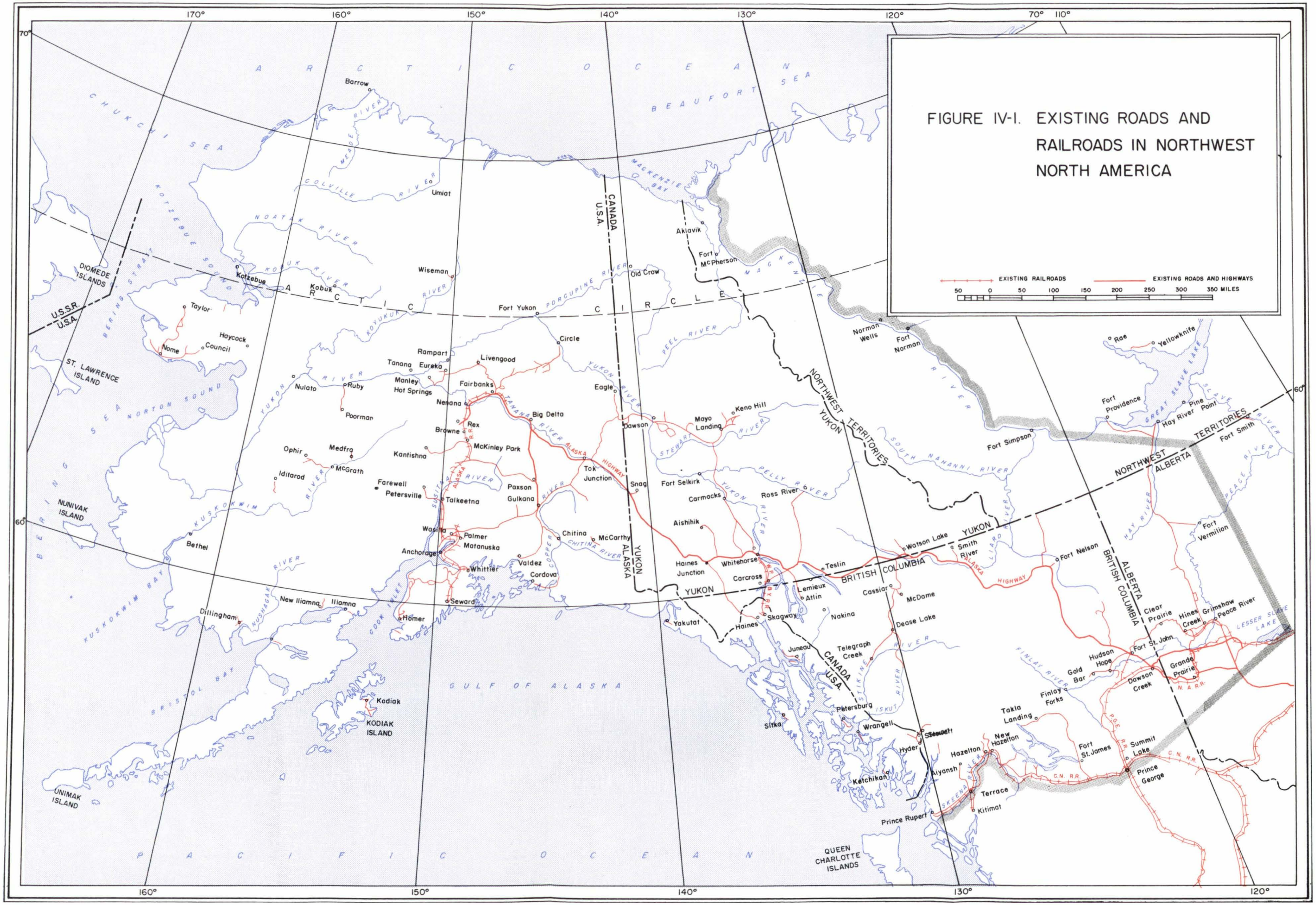

FIGURE IV-1. EXISTING ROADS AND RAILROADS IN NORTHWEST NORTH AMERICA

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establishments in 1958 has been estimated to be about 225. Anchorage has the largest concentration of wholesaling activity in the state – nearly double that of the second ranking city, Fairbanks. An unofficial estimate for 1958 gave Anchorage some 96 establishments, 44 at Fairbanks, and 19 each in Juneau and Ketchikan. Strong effort has been made by Anchorage to supplant Seattle as the traditional warehousing point for Alaska.

TABLE IV-6. VALUE OF WHOLESALE SALES IN ALASKA, BY SELECTED CITIES, 1948 AND 1954[a]

City	1948 Number of Establishments	1948 Value of Sales, $000	1954 Number of Establishments	1954 Value of Sales, $000
Alaska, Total	111[b]	32,216	184	94,721
Anchorage	13	5,790	53	40,505
Fairbanks	7	(c)	24	(c)
Juneau	13	5,179	9	5,892
Ketchikan	12	3,146	15	5,755

(a) Source: "Alaska, Its Economy and Market Potential", U. S. Department of Commerce (1959).
(b) Revised downward to 95 by the Bureau of the Census for purposes of comparison with 1954 figures for the Territory as a whole, but retained here because published data for individual cities have not been so revised.
(c) Withheld to avoid disclosure of individual data.

Table IV-7 shows that the 1958 value of retail sales in Alaska was $187.2 million compared with $174.5 million in 1954, an increase of 7 per cent over this period. The annual payroll of these retail establishments totaled $22.8 million in 1958 compared with $20.8 million in 1954, an increase of 9.6 per cent. The Anchorage and Fairbanks regions account for most of the retail activity in Alaska.

TABLE IV-7. RETAIL TRADE IN ALASKA, 1954 AND 1958[a]

Cities of 2,500 Inhabitants or More

	1954	1958
Number of Establishments	1,510	1,431
Sales, $000	174,514	187,165
Payroll, $000	20,816	22,844

(a) Source: "Retail Trade, Preliminary Area Report," 1958 Census of Business, U. S. Department of Commerce.

Other Services. Receipts for selected services (tourism, auto repair, motion pictures, other amusements, recreation, and similar miscellaneous services) for 1958 totaled

$26.9 million, an increase of $6.7 million, or 33 per cent over 1954. The largest single activity in this group of services was hotels, motels, tourist courts, and camps which accounted for $7.6 million in receipts in 1958.

Table IV-8 presents the latest available information on the selected services activities in Alaska.

Communications and Transportation. Three distinct elements characterize both the communications and transportation activities in Alaska: (1) the relative remoteness of the area, (2) the concentration of population in the Rail belt, and (3) the great undeveloped area between the outlying small, dispersed population centers. Under these conditions, the adequacy of the existing networks becomes a most important consideration. Figure IV-1 shows on a map the existing roads and railroads in the Area. Elsewhere in the report, Figure VII-3 shows airline routes.

Recent developments in the communications field have been substantial. The newly installed facilities of the Alaska Communications System, the "White Alice" network of 33 stations, give Alaska some 3,100 miles of long-distance telephone and telegraph communications.* The recently announced microwave system, to be operated by Canadian National Telegraphs (CNT), links Fairbanks with Sweet Grass, Montana, via some 50 towers located generally along the route of the Alaska Highway in Canada.

In addition to these long-distance communications facilities, there are numerous local newspapers plus radio and television stations in the larger communities. For example, Anchorage supports two newspapers with a combined daily circulation of about 30,000, plus two radio stations and three television stations. Fairbanks and Juneau also have complete coverage by the radio, television, and newspaper media. Elsewhere, newspapers and radio stations are commonly associated with settlement centers that count several thousand persons among their inhabitants.

The area's transportation facilities have similar problems of distance and service. The long-distance connections are adequately served by four scheduled airlines in the Alaska trade; nine intra-Alaska airlines provide additional service. The Alaska Steamship Company and several barge lines provide freight service to the important port cities, hauling some 1.5 million tons of freight (mostly liquid fuels) on a year-round basis.** At Seward and at Whittier (military cargo), the Alaska Railroad picks up the rail freight (including vans) for movement to Anchorage, Fairbanks, and the other Rail belt cities. Truck freight for Alaska arrives either by van-on-barge via Valdez (less then 100,000 tons annually) or overland via the Alaska Highway (up to 13,000 tons in peak years).**

The total revenue freight for the Alaska Railroad in 1958 was $11.3 million compared with $12.4 million in 1957. More details on transportation are presented in Chapters VII and VIII.

*Besides its primary defense function, this extensive network serves Alaskan civilian needs, too.

**Docket No. 881 "Alaska Traffic Pattern During the Past Decade", General Services Administration, June 27, 1960. Also, Docket 881, "Schedule D", Maritime Administration, April 25, 1960.

TABLE IV-8. SELECTED SERVICES IN ALASKA, 1958 AND 1954[a]

Type of Business	1958				1954				Per Cent Increase In Receipts, 1958 over 1954	
	Number of Establishments		Receipts, $000		Number of Establishments		Receipts, $000			
	Total	With Payroll	Total, All Establishments	Establishments With Payroll	Total	With Payroll	Total, All Establishments	Establishments With Payroll	Total, All Establishments	Establishments With Payroll
Selected services, total	814	382	26,913	23,143	694	308	20,234	17,392	33.0	33.1
Hotels, motels tourist courts, camps	159	93	7,639	6,895	149	61	5,326	4,296	43.4	37.2
Personal services	220	128	6,727	6,139	225	115	6,060	5,534	11.0	10.9
Miscellaneous business services	134	48	3,443	2,911	88	32	1,652	1,328	8.4	19.2
Auto repair, auto services, garages	93	41	3,046	2,394	53	17	1,318	968	31.1	42.8
Miscellaneous repair services	106	24	2,288	1,518	87	35	1,985	1,709	15.3	-11.2
Motion pictures	28	22	1,951	1,845	23	19	(b)	(b)	(b)	(b)
Amusement, recreation services, excluding motion pictures	74	26	1,819	1,441	69	29	(b)	(b)	(b)	(b)

(a) Source: "Selected Services, Preliminary Area Report, Alaska, 1958 Census of Business", U.S. Department of Commerce.
(b) Withheld to avoid disclosure of individual data.

Financing. The availability of short-term and long-term funds for business financing in Alaska has been, and still remains, a rather critical problem. Because Alaskan banks ordinarily operate from a smaller deposit and capital base than their counterparts in the lower U. S., short- and intermediate-term credit has not been available on a per capita basis as readily as in the mainland states. At the present time, Alaskan businesses place considerable reliance on short- and intermediate-term credit from banks outside the State. The Small Business Administration of the Federal Government also has been active in business loans in the State.

Life insurance companies generally provide the major source for long-term funds in the U. S. economy. Insurance companies are not well represented in the Alaskan area. Mutual savings banks and savings and loan associations are virtually nonexistent in the State. This, too, has hindered business investments in Alaska.

Table IV-9 presents current monetary statistics for the State of Alaska compared with the U. S.

The Construction Industry

The construction industry in Alaska is unique in several ways. First, it is the largest single contributor to Alaska's private economy, and has been for more than a decade. The payroll of the construction industry in 1957 totaled nearly $64 million. Although nearly 16,000 workers were employed in the construction industry in 1951, only 5,863 were employed in this industry in 1957. Still, in 1957, the construction workers represented approximately one-third of all workers employed in private industry, excepting the supporting industries.

Approximately two-thirds of all contracts for construction in Alaska are for defense-oriented projects. An additional 14 per cent of all contracts are for highways, bridges, and harbor improvements; and approximately 20 per cent for schools, airport facilities, electric power plants, and other private projects.

Total defense construction spending in Alaska in the last 15 years has been estimated at $2 billion. Recently the annual rate of defense construction has been approximately $88 million. A considerable amount of this money has been for such military systems as the distant early warning radar system, the ballistic missile early warning system, and the "White Alice" network. Construction of the new missiles base at Clear has helped to maintain this average figure in 1959 and 1960.

Highway building has been the second most important construction program in Alaska. An approximate annual expenditure of $13 million was authorized by Congress for highway construction in Alaska for each of the years 1958, 1959, and 1960.

According to the U. S. Department of Commerce, building-permit records of the several municipalities in Alaska indicate that private contract construction has totaled about $10 million annually over the past 4 years.

Industrial construction, as such, is almost negligible in the total construction picture of Alaska, except when the two pulp mills were built, in Ketchikan and Sitka in 1952-54 and 1957-59, respectively.

TABLE IV-9. MONETARY STATISTICS - STATE OF ALASKA AND U.S.A.[(a)]

	Figures for Alaska	Per Capita Data Alaska	Per Capita Data U.S.A.
General Bank Data			
Total Bank Deposits 6-30-59	$181,000,000	$800.00	$1,435.00
Bank Capital Funds 6-30-59	11,000,000	49.00	125.00
Number of People per Bank Office	(36 offices)	6,250	7,700
Short- and Intermediate-Term Credit			
Total Loans and Discounts Held by Alaska Banks 6-30-59	$ 70,000,000	$310.00	$ 694.00
Estimate of Participation and Direct Loans Held by Outside Banks for Alaska-Based Activities	$ 20,000,000	$ 89.00	--
Participation and Direct Loans Held by S.B.A. for Alaska-Based Activities 6-30-59	$ 2,900,000	$ 13.00	$ 2.34
Estimate of Loans Held by Outside Banks for Companies with Important Activities in Alaska but with Headquarters Elsewhere	$ 45,000,000	$200.00	--
Total	$137,900,000	$612.00	$ 696.34
Long-Term Credits			
Estimate of Loans of Life Insurance Companies:			
On Commercial and Residential Properties	$ 10,000,000	$ 44.00	$ 127.00
On Industrial Properties	40,000,000	178.00	222.00
Total Insurance Company Loans	$ 50,000,000	$222.00	$ 349.00
Loans Held by Mutual Savings Banks	--	--	135.00
Loans Held by Savings and Loan Associations	--	--	277.00
Municipal Bonds Outstanding	$ 47,000,000	$209.00	$ 316.00
Mortgages Held by Federal National Mortgage Association 6-30-59	48,000,000	213.00	10.00
Total Long-Term Credits from Established Sources	$145,000,000	$644.00	$1,087.00

(a) Source: Paper presented by R. C. McDonald to the 1959 Fall Conference, Pacific Northwest Trade Association, Fairbanks, Alaska.

High labor costs, costs of clearing new land, the necessity for importing nearly all building materials, and the rigorous Alaskan weather all contribute to the problems involved in the construction industry in Alaska.

Personal Income and the Cost of Living

The first official income figures for Alaska were released by the U.S. Department of Commerce in July, 1960. Table IV-10 shows these personal income figures for the years 1950-1959.

Compared with the 1950 figure of $319 million, Alaska's personal income total in 1959 was $556 million, a gain of 75 per cent. The Department of Commerce observed that this gain was slightly in excess of that for the U.S., as a whole, 67 per cent, in this same period. The total purchasing power of individuals in Alaska, in real terms, rose about 40 per cent in the decade 1950 through 1959. The per capita income of the residents of Alaska was $2, 550 in 1959, or 18 per cent higher than the U.S. national average of $2, 160.

Of the total 1959 personal income in Alaska of $556 million, $281 million, or one-half, was paid to residents by private industry; $239 million, or 43 per cent, by the Federal Government; and $37 million, or 7 per cent, by state and local governments. The Federal Government's relative contribution to personal income in Alaska is higher than in any other state in the U. S.

In part, because Alaskans draw high wages, and their state is in a remote location from the mainland of the U.S., the cost of living is abnormally high. Figure IV-2 shows the "Ward Index of Consumer Prices" for seven Alaskan cities in the years 1956 through 1959. This index uses 1956 consumer price figures in Seattle as a basis of comparison (Seattle, 1956 = 100). All seven Alaskan cities shown have a higher consumer price index than Seattle. This has been true in each of the 4 years studied. Nome, the city highest in terms of cost of living, has been steadily 50 per cent higher than Seattle. Interestingly enough, the figures show that the cost of living rises nearly proportionately to northward and westward distances from Seattle.

Conclusions

A general investigation of the major economic activities in the State of Alaska reveals several important factors. Essentially, there is no industrial base within the State. Only relatively minor activities in wood pulp, canning of fish, and isolated instances of minor consumer-goods production represent the manufacturing activity in Alaska.

It must be accepted that the economy of Alaska is largely based on the military activities found in the State and the "supporting" industries which must be present to assist the military activity and the limited natural-resource development of the State.

TABLE IV-10. PERSONAL INCOME IN ALASKA, BY MAJOR SOURCES, 1950-1959[a]

Millions of Dollars

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
Personal Income	319.0	439.0	485.0	506.0	493.0	500.0	548.0	537.0	527.0	556.0
Government Income Disbursements	165.5	200.8	240.3	265.2	265.7	276.4	277.2	280.8	272.2	275.9
Federal	153.0	185.1	223.6	245.8	245.4	252.5	247.5	250.6	238.7	238.9
Net Civilian Earnings	61.5	67.5	76.4	85.7	83.6	88.8	90.5	91.1	100.7	107.1
Military Earnings	82.0	109.5	136.3	147.2	147.0	148.7	142.2	142.2	118.7	112.3
Other	9.5	8.1	10.9	12.9	14.8	15.0	14.8	17.3	19.3	19.5
State and Local	12.5	15.7	16.7	19.4	20.3	23.9	29.7	30.2	33.5	37.0
Private Income	153.7	238.2	244.5	241.1	227.7	223.2	270.6	256.5	254.6	280.6
Earnings of Persons in:										
Contract Construction	38.4	84.0	74.9	69.2	59.6	53.7	79.4	58.5	50.5	51.2
Manufacturing	13.5	13.6	15.7	16.8	15.4	17.5	22.0	21.5	19.1	22.8
Fish Processing	7.0	6.1	7.3	7.9	3.6	3.8	5.9	5.4	3.9	3.4
Other Manufacturing	6.5	7.5	8.4	8.9	11.8	13.7	16.1	16.1	15.2	19.4
Mining	11.2	11.2	12.6	12.2	10.1	9.3	9.8	10.6	9.5	10.8
Fishing	9.6	11.5	11.6	8.9	11.5	9.8	12.5	11.0	10.9	9.5
Agriculture	6.1	7.3	7.4	8.2	9.6	8.0	7.3	7.5	7.2	6.8
Trade	29.4	43.2	47.1	47.1	44.7	43.5	47.8	50.3	48.1	56.7
Services	13.4	25.5	24.8	21.3	18.5	21.7	25.3	27.4	29.8	37.8
Transportation	13.9	19.9	23.8	25.4	24.3	23.9	27.6	26.2	27.7	30.4
Finance, Insurance, and Real Estate	3.1	4.2	5.4	7.0	7.6	7.8	8.2	8.9	10.0	11.6
Communications and Public Utilities	1.6	1.8	2.2	2.5	3.0	3.1	4.1	6.9	14.1	13.7
Less: Personal Contributions for Social Insurance in Private Industry	1.0	1.6	2.1	2.0	2.3	2.7	3.1	3.4	3.6	3.9
Other Income	14.5	17.6	21.1	24.5	25.7	27.6	29.7	31.1	31.3	33.2
Per Capita Income, dollars	2,246	2,629	2,487	2,387	2,282	2,294	2,502	2,408	2,486	2,550

(a) Source: U. S. Department of Commerce, Office of Business Economics.

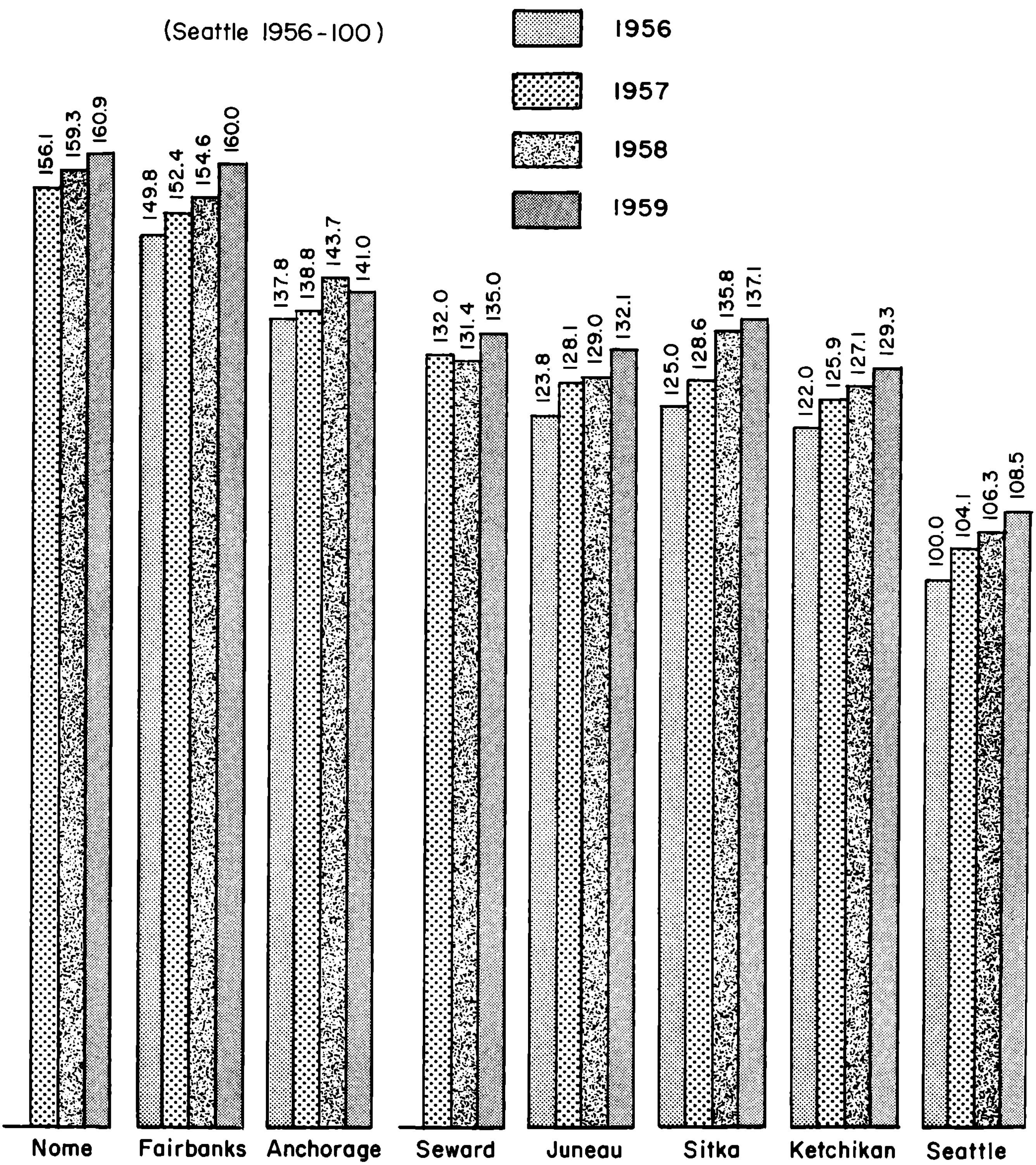

FIGURE IV-2. COST OF LIVING INDEXES OF SEVEN ALASKAN CITIES COMPARED WITH SEATTLE, 1956-1959

Source: 1959 Consumer Price Index in Seven Alaskan Cities, State of Alaska, Department of Natural Resources.

At the present time, the exploitation of the natural resources (minerals, forests, fish, game, and tillable land) is not a significant portion of the total economic activity of Alaska. The construction industry is important to the economy, but it is closely allied with the military activities.

The internal, or domestic, markets of Alaska are presently inadequate to support a growing industrial base within the State. The size of the present population in Alaska does not justify large processing firms or consumer-goods companies to serve just the local market. Most of these firms could start only if there were an opportunity to sell in foreign markets.

Realistically, the cost of living is high in Alaska, making it necessary for new labor coming into the area to command a high wage figure in order to meet this cost of living. High wage scales, then, become a major factor in attempting to establish new industry in the State. Risk capital needed from outside the State is often difficult to obtain under these circumstances.

Northwestern Canada

To the east and southeast of Alaska lies an area, of approximately 500,000 square miles, to be considered in this report in addition to the State of Alaska. This northwestern part of Canada includes roughly Yukon Territory, a strip of the Northwest Territories between the Yukon and the Mackenzie River, Census District 15 in Alberta, part of Census District 8, and virtually all of Districts 9 and 10 in British Columbia.

Analyzing the economic structure of this area presents two unique problems:

(1) Because the total area is not a recognizable political boundary, economic data must be integrated from the separate parts of the area.

(2) The sparse population and the limited economic development in the area mean that relatively little economic information can be reported.

Recognizing these problems, the following sections treat the general economy of northwestern Canada. Little reference is made to the strip of the Northwest Territories and that part of Census District 8 in British Columbia, since the latter includes largely population centers lying on the very border of the Area. Appropriate information is not available in the required form for these two areas. However, lack of this information is not considered to detract from the general economic analysis of northwestern Canada.

Population

In 1956 the total population of northwestern Canada was only 140,332. Half of these people were in the southeastern portion of the area, or Census District 15 of Alberta. Nearly 43 per cent were in the southeastern and south central portions of the area (Census Districts 9 and 10 of British Columbia), and only about 7 per cent were in the northern half of the area (Yukon Territory).

Prince Rupert is the largest city in northwestern Canada with a population of 10,498.* Grand Prairie ranks second with a 1956 population of 6,000, followed by Whitehorse with 2,570 and Peace River with 2,000.

Manufacturing

The annual selling value of factory shipments made in northwestern Canada is approximately $160 to $170 million. Table IV-11 presents the selling value of factory shipments from the various parts of northwestern Canada.

TABLE IV-11. SELLING VALUE OF FACTORY SHIPMENTS IN NORTHWESTERN CANADA FOR 1955, 1957, AND 1958[a]

Yukon and Northwest Territories (1955)[1]	$ 4,761,000
Census District 15, Alberta (1957)[2]	20,283,371
Census District 9, British Columbia (1958)[3]	129,000,000
Census District 10, British Columbia (1958)[3]	8,000,000
Representative Total	$162,034,371

(a) Sources: 1. "Canada Year Book, 1957-58", Dominion Bureau of Statistics, Ottawa, p 636.
2. "Alberta Industry and Resources, 1959", Alberta Bureau of Statistics, Department of Industry and Development, p 30.
3. "British Columbia Manual of Resources and Development, 1959", 2nd Edition, Bureau of Economics and Statistics, Department of Industrial Development, Trade and Commerce, p 26.

About 80 per cent of all factory shipments in northwestern Canada are made in the southwestern portion of the area. These shipments are principally nonferrous metals, food and beverage, pulp and paper, wood, and nonmetallic minerals such as petroleum products and sulfur. The southeastern area has some clay and glass manufacturing, an oil refinery, a plywood plant, and several lumber mills. Limited activity in food and beverages and printing and publishing is found in the northern half of the area.

Natural Resources

Mineral Resources. Production of minerals in northwestern Canada is dominated by output of oil and gas in the Peace River district of British Columbia and Alberta;

*Prince George, in Census District 8, with a population of 10,563 in 1956, is comparable in size with Prince Rupert. Both lie on the very southern border of the area under study.

asbestos from Cassiar, British Columbia; silver, lead, and zinc from United Keno Hill in Central Yukon; and gold from the Klondike area of west central Yukon. In terms of value of output in 1958, the oil and gas production of the Peace River district in British Columbia and Alberta ($21.4 million) was practically identical to the metals and minerals output of British Columbia and Yukon ($21.6 million), as shown by Table IV-12.

TABLE IV-12. VALUE OF PRODUCTION OF METALS, MINERALS, AND FUELS FROM NORTHWESTERN CANADA, 1958

Millions of Dollars

	Yukon Territory	Northern British Columbia	Northwestern Alberta	Total
Oil		1.0	12.9	13.9
Gas		3.9	3.6	7.5
Sulfur		0.8		0.8
Coal	0.03	0.07		0.1
Metals and Minerals	11.8	9.8		21.6
Total	11.83	15.57	16.5	43.9

Agriculture, Forestry, and Fishing. Almost all of the agricultural activity in northwestern Canada is found in the southeastern area from about Fort St. John and Dawson Creek eastward to the Grand Prairie complex. There is only minor agricultural activity in Yukon Territory. Total values of 1956 commercial agricultural production from British Columbia and Alberta were as follows: northern British Columbia $7.7 million, and northwestern Alberta $32.6 million.

Agriculture in the Fort St. John area is principally crop-raising since the land is virtually valueless as range land. In the Grand Prairie-Peace River complex, cattle, hogs, sheep, and poultry are raised. This area is also prominent for grain crops.

Of the 70,000 people located in the Alberta portion of the study, about 12,000 are classified as urban and 58,000 as rural. Of the 58,000 rural, 35,000 are on farms and 23,000 are nonfarm rural.

Yukon Territory has over 330 million board feet of accessible timber on an annual allowable cut basis. This is predominantly softwood and is concentrated in the southern portion of the territory. The allowable annual cut in northwestern Alberta amounts to 1,900 million board feet of softwoods and 1,600 million hardwoods. In northern British Columbia, the currently allowable annual cut in accessible areas is 7,200 million board feet. Those forests in the interior of this area are generally more immature and of lower grade than near the coast.

Currently, less than 2 per cent of the allowable annual cut in Yukon Territory is actually being produced; 5 per cent of allowable cut is being utilized in northwestern Alberta; and in northern British Columbia, about 15 per cent of the annual allowable cut is being tapped.

Significant fishing activity in northwestern Canada is confined to the coastal area in the British Columbia sector. In 1958, the wholesale value of all fish products in British Columbia was $98 million. A sizable share of these fish was caught and processed in the Prince Rupert area. The salmon catch is of primary importance, followed by herring, halibut, crabs, and shrimp.

Hydroelectric Power. Although the hydroelectric potential of northwestern Canada is large, the developed power in this area is only about 28,000 kw. Most of this is in the northern half of the area. The potential hydroelectric power in the British Columbia sector is about 5 million kw. First step toward utilizing the potential in British Columbia is the Peace River power project currently being pushed with vigor. No hydroelectric power is available in the Alberta sector of the study area.

Transportation

Highway transportation in northwestern Canada is confined principally to the Alaska Highway running from Dawson Creek to Whitehorse and into Alaska. Major highways are also found in the Grand Prairie-Peace River complex, connecting with Dawson Creek and the Alaska Highway to the north and with Edmonton, Alberta, to the south. A number of other unpaved spur roads or highways are found, as shown in Figure IV-1. These exist to serve various mining, forest, and tourist activities.

A rail line running from Skagway, Alaska, to Whitehorse is the only railroad in the Yukon. The Northern Alberta Railway passes through Grand Prairie and connects with the Pacific Great Eastern Railway at Dawson Creek. The PGE serves the area from Fort St. John to Prince George, and then on down to north Vancouver. Prince Rupert serves as a western terminal for the Canadian National Railway, which follows the southern boundary of the study area as far as Prince George. A start has been made on construction of the proposed Wenner-Gren rail line between Gladys Lake and Summit Lake in British Columbia.

Sea transport for northwestern Canada is centered principally around the Prince Rupert area. A number of deep, ice-free harbors are found here. Active coastal shipping and trade with the Far East are carried on.

Conclusions

Northwestern Canada is a vast, sparsely populated territory, having no major cities or centers of industrial development. Adding together the economic activities of only 140,000 people, spread over an area of nearly 500,000 square miles, can only result in patches of economic activity such as gold and silver mining in the Yukon, oil and gas production around Dawson Creek and Grand Prairie, scattered logging camps, and fishing from the coastal area surrounding Prince Rupert.

Significant mineral deposits are not in evidence in the area. Because the economy is extremely small and distances are great, the development of the potential hydro-electric power has not been undertaken, although plans are being pushed for the huge Peace River project. Manufacturing is insignificant, and the one agricultural region in the area exists to serve markets to the south.

V. NATURAL RESOURCES — PAST, PRESENT, AND FUTURE

Economic growth of Northwest North America will be dependent largely on development of the natural resources of the Area - its metals and minerals, coal, petroleum, natural gas, hydro power, forests, fish, furs, agriculture, and the many natural, historic, and cultural features that attract tourists to the Area. These resources are even more directly concerned with this study, however, since conclusions and recommendations on improved transportation needs in the Area must be based largely on benefits to be gained from such improvements in the exploitation and development of these resources in the period 1960-1980.

In describing and appraising these natural resources the general pattern followed is discussion of:

(1) Historic development, including past production records generally covering the 20-year period 1939-1958

(2) Resources or reserves, as best known at present, and their general location

(3) Potential uses and markets for the resources in the period 1960-1980, with consideration given to technological developments affecting future uses and markets

(4) Transporation needs for economic exploitation, and estimated tonnages that might be moved

(5) Potential impact on the Area's economy by the resource developments that can be foreseen as possible or probable in the next 20 years.

In presenting the resource data, past production and resources or reserves are discussed separately for Alaska, Yukon Territory, northern British Columbia, and northwestern Alberta, with Canadian parts sometimes combined. Census and mining divisions of British Columbia and Alberta do not coincide precisely with the areas covered by this study, but are close enough for the purposes to be served.

It must be recognized that the broad scope of investigations involved has dictated care in concentrating time and effort on those specific resources that appear to offer most promise for development. Detailed discussion of uses and markets for each of the 25 metals and industrial minerals known to occur in the Area, for example, obviously is impossible; attention has therefore been concentrated on the relatively few that appear most promising.

It should also be pointed out that large-scale development of many resources in the Area - many metals, petroleum, and natural gas, for example - is dependent in major part on what is <u>discovered</u> in the Area in the future rather than on development of such resources that are <u>known</u> to occur there at present. A serious attempt has been made to base estimates of future development, economic impact, and transportation needs largely on resources that are known to occur in the Area at present, with conjecture on effects of additional discoveries kept separate and plainly indicated as such.

Certain other details, such as possible resource-processing methods and costs, estimated value of new products, estimated employment and other population increase that might result from new resource-processing enterprises, have no direct bearing on transportation needs. However, they may bear importantly on other local resource needs (coal and electric energy in iron-ore smelting, for example) and especially on the economic benefits to the region if such resource developments transpired – necessary in comparing the costs versus the benefits of improved transportation facilities.

In the case of metals and minerals, considerable space has been devoted to outlining briefly, at least, the presently estimated quantity and grade of the better-known deposits in the Area, even though in many cases they are decidedly submarginal. Brief reference is also made to quantity and grade of estimated reserves and to size and grade of important deposits presently being brought into production elsewhere in the world. These details are included in order to provide at least a degree of documentation of the broad conclusion that, except for the few potential commercial developments noted, future major metal and mineral developments in the Area will have to come from new discoveries. This conclusion is quite at variance with the popular belief, so frequently expressed, concerning the "fabulous mineral wealth" of the Area that needs only a railroad or a highway to make its development economic, and it was felt that the above-mentioned documentation was therefore highly desirable.

METALS AND MINERALS

Northwest North America, especially Alaska and Yukon Territory, have long been spoken of as a "vast storehouse of mineral wealth". Doubtless this was an outgrowth of the bonanza output during the decade or so at the turn of the century in the Klondike-Yukon-Nome gold-rush days, followed later by the fabulous output from Alaska's Kennecott copper mine and from the Keno Hill silver-lead-zinc mine in the Yukon. The record justifies this, for minerals with a total value of almost $2 billion have been produced in the area under study from 1880 to 1959, inclusive. Of this total, Alaska produced about $1. 2 billion, the Yukon about $0. 39 billion, and northern British Columbia about $0. 37 billion.

Of the Alaskan output, gold has accounted for 61 per cent, copper for 19 per cent (virtually all from the Kennecott mine), coal for 7 per cent, and silver for 1 per cent.

Production of the principal metals and industrial minerals in the region is shown for the years 1939-1959, inclusive, in Table V-1. Outputs for Alaska, the Yukon, and northern British Columbia are shown separately, with both quantity and value given. Reference will be made to data in this table in the discussions of each of the metals and minerals that follow.

Mining and Exploration Activity

Following the recession of the 1930's, the supply requirements for World War II focused some attention on this region as a source of strategic metals and minerals. The only major developments that grew out of this effort were two mercury mines – the Red Devil in southwestern Alaska and Pinchi Lake in central British Columbia.

Construction of the Alaska Highway in 1942 opened up a broad swath of previously inaccessible area to exploration, and later construction of the Mayo road north of Whitehorse in 1952 spurred both exploration and output from the Mayo district, permitting virtually year-round fast truck transportation of concentrates to the White Pass Railroad at Whitehorse, thence to Skagway, and by boat to markets far to the south. Up to then, transportation of supplies to and concentrates from this important district was dependent on movement by boat on the Stewart and Yukon Rivers to Whitehorse in the summertime.

During the late 1940's, a large number of reports were issued by the Geological Survey and Bureau of Mines, U. S. Department of the Interior, describing geological and development work done on many metal and mineral deposits in Alaska under the Strategic Minerals Program during and following World War II.

The Korean War in the early 1950's sparked a much heavier effort by the U. S. Government and industry to develop and expand mineral output to meet growing needs for the war effort and for an accelerated stockpiling program. This resulted in only minor contributions from Alaska – expanded but minor output of antimony, tin, and a little tungsten. These were dwarfed by the effects of the military construction program in Alaska, which brought sand and gravel up into the group of major minerals produced.

TABLE V-1. PRODUCTION OF THE PRINCIPAL METALS AND MINERALS IN NORTHWEST NORTH AMERICA, 1939-1959, INCLUSIVE (BRITISH COLUMBIA THROUGH 1958)

Year	Antimony Ore and Concentrate: Antimony Content, short tons	Antimony Ore and Concentrate: Value, $000	Chromite Gross Weight: Short Tons	Chromite Gross Weight: Value, $000	Copper: Short Tons	Copper: Value, $000	Gold: Troy Ounces	Gold: Value, $000	Lead: Short Tons	Lead: Value, $000	Mercury: Flasks (76 Pounds)	Mercury: Value, $000	Platinum-Group Metals: Troy Ounces	Platinum-Group Metals: Value, $000	Sand and Gravel: 000 Short Tons	Sand and Gravel: Value $000	Silver: 000 Troy Ounces	Silver: Value $000	Stone: 000 Short Tons	Stone: Value $000	Tin: Tin Content, short tons	Tin: Value, $000	Tungsten Concentrates 60 Per Cent WO_3 Basis, short tons	Tungsten: Value, $000	Zinc: Zinc Content, short tons	Zinc: Value, $000	Value of Items That Cannot Be Disclosed, $000	Total Value (Alaska, including Coal), $000	Year
Alaska																													
1939	(a)	(a)	-	-	128	527	676,739	23,686	937	88	-	-	31,300	997	42	23	201	136	(a)	(a)	37	37	-	-	-	-	94	25,673	1939
1940	(a)	(a)	-	-	55	12	755,970	26,459	779	78	162	29	32,300	1,093	515	103	192	136	(a)	(a)	52	52	-	-	-	-	67	28,724	1940
1941	(a)	(a)	-	-	72	17	695,467	24,341	662	75	-	(a)	24,600	1,078	531	87	192	136	-	-	52	(a)	-	-	-	-	130	26,809	1941
1942	(a)	(a)	-	-	22	5	487,621	17,067	415	56	(a)	(a)	(a)	(a)	(a)	(a)	120	85	-	-	(a)	(a)	(a)	(a)	-	-	1,258	20,094	1942
1943	405	33	6	186	27	7	99,583	3,485	200	30	786	153	(a)	(a)	43	30	(a)	(a)	(a)	(a)	-	-	10	(a)	-	-	3,286	9,055	1943
1944	73	6	2	64	2	1	49,296	1,725	44	7	(a)	(a)	33,616	(a)	712	499	13	10	(a)	(a)	-	-	19	(a)	-	-	2,350	6,903	1944
1945	-	-	-	-	5	1	68,117	2,384	11	2	(a)	(a)	26,505	(a)	(a)	(a)	10	7	(a)	(a)	-	-	-	-	-	-	5,911	10,174	1945
1946	-	-	-	-	2	1	226,781	7,937	115	25	699	69	22,882	(a)	-	-	42	34	(a)	(a)	-	-	19	(a)	-	-	2,005	12,426	1946
1947	40	16	-	-	12	5	279,988	9,800	264	76	127	11	13,512	(a)	(a)	(a)	66	60	(a)	(a)	1	2	13	(a)	25	6	5,957	18,488	1947
1948	68	29	-	-	16	7	248,395	8,694	329	118	100	8	(a)	(a)	-	-	67	61	41	55	6	(a)	-	-	22	6	1,258	13,024	1948
1949	74	31	-	-	4	2	229,416	8,030	51	16	100	8	(a)	(a)	-	-	36	33	(a)	(a)	57	115	-	-	2	1	4,005	15,549	1949
1950	-	-	-	-	7	3	289,272	10,125	149	40	-	-	(a)	(a)	3,050	2,377	53	48	-	-	88	170	13	(a)	6	2	2,055	17,852	1950
1951	301	(a)	-	-	-	-	239,639	8,387	22	8	-	-	(a)	(a)	6,888	3,739	33	30	-	-	77	197	10	(a)	-	-	3,441	19,569	1951
1952	420	(a)	-	-	-	-	240,557	8,419	-	-	28	6	(a)	(a)	10,782	8,651	33	30	(a)	(a)	92	221	8	(a)	-	-	3,195	26,302	1952
1953	-	-	-	-	-	-	253,783	8,882	9	2	40	8	(a)	(a)	7,689	5,080	35	32	47	170	55	106	3	(a)	-	-	1,521	24,252	1953
1954	-	-	3	208	4	2	248,511	8,698	-	-	1,046	277	(a)	(a)	6,640	6,302	34	31	284	466	223	410	-	-	-	-	1,572	24,408	1954
1955	-	-	7	625	1	1	249,294	8,725	1	(b)	(a)	(a)	(a)	(a)	9,793	8,242	34	31	266	290	96	183	-	-	-	-	1,552	25,412	1955
1956	28		7	711			209,296	7,325	1	(b)	3,280	853	(a)	(a)	5,955	5,880	28	26	195	595	-	-	-	-	-	-	1,644	23,408	1956
1957	17	4	4	431			215,469	7,541	9	3	5,461	1,349	(a)	(a)	6,096	8,799	29	26	528	1,953	-	-	-	-	-	-	1,390	28,792	1957
1958	-	-			5	3	186,435	6,525	2	(b)	3,380	774	(a)	(a)	4,255	3,871	24	22	615	2,065	-	-	-	-	-	-	1,253	21,450	1958
1959	-	-					171,000	5,985	-	-	3,750	852	-	-	5,600	5,100	22	20	54	210	-	-	-	-	-	-	7,698	19,880	1959
Yukon Territory			Cadmium: 000 Pounds	Cadmium: Value, $000																									
1939			-	-			87,745	3,171	3,772	239							3,831	1,551							-	-		4,961	1939
1940			-	-			80,458	3,098	2,328	157							2,259	864							-	-		4,118	1940
1941			-	-			70,959	2,732	852	57							857	328							-	-		3,118	1941
1942			-	-			83,246	3,205	681	44							482	203							-	-		3,454	1942
1943			-	-			41,160	1,585	98	7							52	24							-	-		1,626	1943
1944			-	-			23,818	917	53	5							32	14							-	-		939	1944
1945			-	-			31,721	1,221	60	6							25	12							-	-		1,239	1945
1946			-	-			45,286	1,664	28	4							31	26							-	-		1,694	1946
1947			-	-			47,745	1,671	572	157							372	268							-	-		2,096	1947
1948			-	-			60,614	2,121	2,300	830							1,719	1,289							-	-		4,266	1948
1949			-	-			81,970	2,951	2,678	846							1,563	1,160							424	112		5,099	1949
1950			56	131			93,339	3,552	6,443	1,862							3,203	2,588							2,753	862		9,036	1950
1951			66	178			77,504	2,856	6,267	2,306							3,443	3,255							2,840	1,130		9,793	1951
1952			129	285			78,519	2,691	9,185	2,974							4,029	3,365							5,535	1,933		11,388	1952
1953			238	477			66,080	2,274	15,796	4,083							6,639	5,578							9,014	2,156		14,569	1953
1954			253	430			82,808	2,801	16,883	4,501							6,992	5,822							11,823	2,833		16,589	1954
1955			212	360			72,201	2,492	13,375	3,775							5,712	5,037							10,911	1,979		14,725	1955
1956			253	430			73,240	2,522	12,900	3,998							6,171	5,536							10,394	3,078		15,679	1956
1957			186	316			73,962	2,481	12,493	3,489							6,484	5,665							8,560	2,070		14,112	1957
1958			163	247			69,210	2,352	10,795	2,445							5,860	5,091							7,264	1,578		11,773	1958
1959			140	179			66,958	2,248	10,970	2,328							6,901	6,059							6,170	1,510		12,373	1959
British Columbia (c)	Asbestos: Short Tons	Asbestos: Value, $000																											
1939	-	-	-	-	63	13	91,689	3,314	472	30							964	390					-	-	12	1			1939
1940	-	-	-	-	68	14	88,380	3,398	584	39	2,024	354					679	260					-	-	37	3			1940
1941	-	-	-	-	184	37	84,265	3,244	1,013	68	7,057	1,335					591	226					-	-	38	3			1941
1942	-	-	-	-	109	21	65,908	2,537	969	65	13,630	2,942					492	207					104.5	232	7	1			1942
1943	-	-	-	-	57	13	22,157	853	949	71	22,240	4,559					336	152					421	671	-	-			1943
1944	-	-	-	-	60	14	15,430	594	910	82	9,682	1,210					110	47					-	-	-	-			1944
1945	-	-	-	-	47	12	14,492	558	1,281	128	-	-					84	39					-	-	-	-			1945
1946	-	-	-	-	-	-	11,519	423	585	79	-	-					38	32					-	-	-	-			1946
1947	-	-	-	-	-	-	39,960	1,224	1,108	303	-	-					73	53					-	-	13	3			1947
1948	-	-	2	3	-	-	37,926	1,327	444	160	-	-					107	80					-	-	157	44			1948
1949	-	-	12	25	-	-	40,741	1,467	441	139	-	-					1,816	1,349					-	-	758	201			1949
1950	-	-	56	134	-	-	52,253	1,988	2,813	813	-	-					3,273	2,639					-	-	2,935	885			1950
1951	-	-	58	159	61	34	23,910	881	3,161	1,163	-	-					3,065	2,898					-	-	3,271	1,481			1951
1952	20	23	110	237	1,247	775	18,144	622	4,917	1,585	-	-					3,719	3,092					328	1,296	8,369	2,657			1952
1953	3,102	989	130	256	2,086	1,266	24,199	833	5,019	1,331	-	-					2,763	2,315					515	1,429	11,170	2,385			1953
1954	8,599	2,921	98	161	2,296	1,337	23,657	806	4,350	1,190	-	-					3,589	2,978					420	1,071	10,264	2,138			1954
1955	17,187	4,265	74	125	2,376	1,819	22,510	743	3,271	977	-	-					2,689	2,362					-	-	9,354	2,269			1955
1956	20,356	6,620	78	129	2,649	2,108	14,763	508	3,589	1,131	-	-					3,015	2,694					-	-	8,737	2,320			1956
1957	31,714	9,246	90	146	1,958	1,019	16,914	567	5,062	740	-	-					3,031	2,638					-	-	10,725	2,464			1957
1958	30,078	8,203	12	18	9	4	522	18	987	232	-	-					1,489	1,287					-	-	486	97			1958

(a) Data not shown; values included under column of items that cannot be disclosed.
(b) Less than $1000.
(c) Omits a small area north and east of Prince George that lies within area under study.

The program of U. S. Government purchases at premium prices following the Korean War resulted in minor shipments of chromite from the Kenai area from 1954 to 1957. Virtual cessation of the Government purchase and stockpiling program in 1958 put an end to the few previous efforts to mine some of the strategic minerals in the area. Rising costs in the past two decades, coupled with the fixed price for gold, have resulted in lowered production of this metal.

However, full realization by the major metal companies of the long-term problem faced by them in providing assured reserves to meet expanding future demands has resulted in greatly accelerated world-wide exploration programs during the 1950's. The area under study has shared importantly in this general effort. Such exploration activities have been concentrated on the following areas in the region under study: (1) Southeastern Alaska, (2) southern Yukon Territory, (3) eastern margin of the Coast Mountains in British Columbia, (4) Kuskokwim River area of southwestern Alaska, and (5) Kobuk River area of northwestern Alaska.

Smitheringale et al.[1] estimate that an approximate minimum of $25 million has been spent since 1940 on exploration of mineral deposits in northern British Columbia, with emphasis having been given to the 30 per cent of the country with relatively exposed rock outcrop above the timber level. They aver, moreover, that "most, if not all, of the oxidized or gossan areas above timber line have been examined", but that "these examinations have been made against a background of remoteness and limited transportation" that will justify some later re-examination. Probably expenditures of at least comparable amounts have been made during that 20-year period in each of southern Yukon Territory and Alaska.

By and large, what has this effort yielded in the discovery of major, steady mineral products? The number is brief, indeed, listed as follows: (1) Red Devil mercury mine in Alaska, (2) Cassiar asbestos mine in northwestern British Columbia, and (3) Canada Tungsten Mining Company's large tungsten deposit in Northwest Territories just east of the Yukon Territory line (steady operations definitely planned starting in 1961).

However, the exploration work over this period has also yielded large numbers of prospects of varying size and grade on which varying amounts of development work have been done. Some of these will certainly become active in the next two decades, with their commercial exploitation depending on more favorable conditions in world markets.

Maps showing locations of the better known metal and mineral deposits were derived from sources too numerous to cite in detail. However, most of the locations in Alaska were taken from a recent map prepared by the Alaska State Department of Mines entitled "Better-Known Mineral Deposits, Petroleum Possibilities, and Existing and Proposed Roads"; and many occurrences in the Yukon were taken from the map accompanying an unpublished report by A. E. Aho on "Mineral Possibilities of Yukon Territory", March 1958.

A series of four maps was issued in the summer of 1960 by the U. S. Geological Survey[50a, b, c, d] showing occurrences of thirteen metals in Alaska. These also showed quadrangle boundaries and listed references of Government publications that describe the occurrences of specific metals in each quadrangle. These maps were of only limited use for locations of significant metal deposits, because the Survey points out in an explanatory note, "No attempt has been made to evaluate the occurrences on the basis of size; well-explored deposits with large reserves....are shown by the same symbol as occurrences that are essentially mineralogical curiosities." However, these maps were useful in the preparation of Figure V-10, which shows the comparative lode potential of areas in the region under study. This map is presented and discussed briefly in the Summary on page V-68.

Iron Ore

Past Production

So far as is known, no commercial production of iron ore has come from the area under study. Quantities measured in thousands of tons have been produced (some shipped out of the area) for purposes of beneficiation and smelting tests.

Reserves

Technical advances during the past 15 years in the beneficiation of low-grade iron deposits, and discovery of greatly improved operations of blast furnaces by use of higher grade agglomerated ore or concentrate, have had a marked influence on the definition of iron-ore reserves of the world, including the area under study. Prior to these developments, deposits generally had to carry close to 50 per cent of iron to be considered commercial, except under special conditions where lower grade material was situated close to supplies of limestone and coal in proximity to markets for iron or steel. Now, deposits down as low as 20 per cent or even 10 per cent of iron are being given serious consideration for future exploitation in the Area.

Generally speaking, the reserves of potential ore in the Area may be grouped into two broad classes:

(1) Relatively small deposits running as high as several million tons of medium-grade iron ore carrying around 40 to 50 per cent of iron, generally less than 1 per cent of copper, traces of gold and silver, and usually relatively high sulfur. Most of the contained iron is in the form of magnetite, and the copper is commonly present as chalcopyrite (the copper-iron sulfide). These deposits are termed "contact-metamorphic" or "replacement" type by geologists and are generally found south of the Petersburg-Wrangell area in Southeastern Alaska.

(2) Huge bodies of titaniferous magnetite disseminated in and associated with large basic igneous intrusives that are measured in hundreds of millions of tons of material carrying around 15 to 20 per cent of iron and a few per cent of titanium. These are termed "magmatic" type and are found generally in the portion of Southeastern Alaska north of the Petersburg-Wrangell region; one (Kemuk Mountain) has recently been discovered by drilling through surface overburden in the geologically similar area a short distance north of Dillingham in southwestern Alaska (Figure V-1, No. 8).

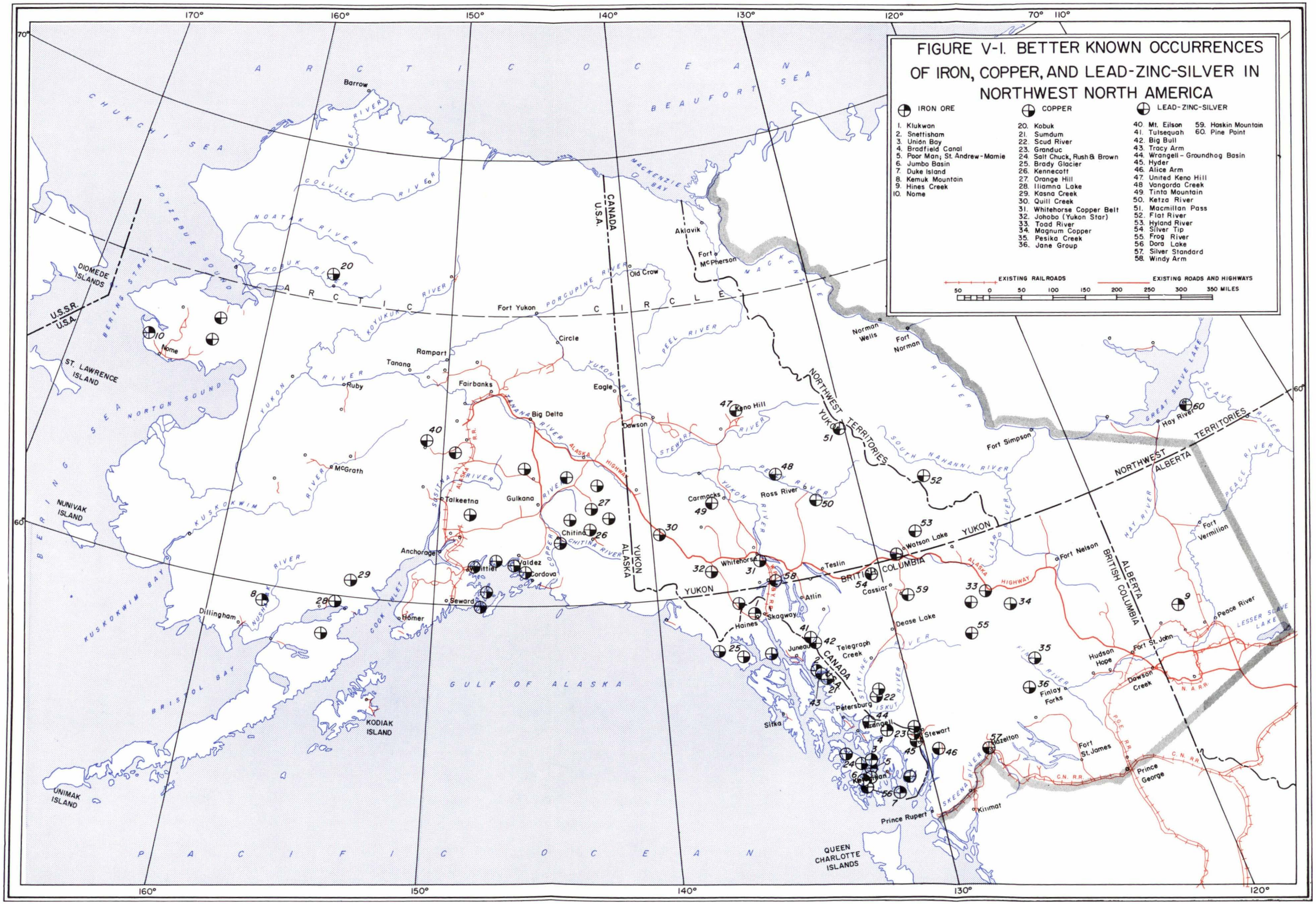

FIGURE V-1. BETTER KNOWN OCCURRENCES OF IRON, COPPER, AND LEAD-ZINC-SILVER IN NORTHWEST NORTH AMERICA

Thin beds of iron formation similar to the Algonkian types in the Lake Superior region running 25 per cent or less of iron and associated with dolomites have been reported just north of Eagle near the Yukon Territory line in eastern Alaska. Also, boulders and fragments of hematite iron formation have been reported from many spots in the Ogilvie Mountains in west- and north-central Yukon Territory north and northeast of Dawson, and within and north of the Mayo mining district.[2a] These occurrences can only be considered as indications that deposits of significant size and grade might be found by further prospecting. A large deposit of low-grade material varying from 22 to 40 per cent of iron is known to occur in western Alberta just north of Hines Creek (Figure V-1, No. 9). This deposit is reported to cover an area of about 43 square miles with an average thickness of some 10 feet, comprising about 1 billion tons. The possibility of smelting this by some sponge-iron process using nearby supplies of natural gas might appear attractive if sizable markets for iron and steel were closer at hand.

Location of the better known occurrences of iron ore in the Area are shown in Figure V-1. Brief descriptions will be given of those deposits that appear most promising for commercial exploitation during the period 1960-1980.

(1) Klukwan Alluvial Fan. Located about 25 miles northwest of Haines on the Haines Cutoff of the Alaska Highway (Figure V-1, No. 1), this is a detrital deposit accumulated by weathering and erosion at the base of the large Klukwan magmatic lode deposit in the mountain to the east. The U. S. Geological Survey has estimated that the fan deposit comprises around 500 million tons of material containing an average of 10 per cent of magnetic iron (plus or minus 3 per cent).[3] Columbia Iron Mining Company of United States Steel Corporation has done considerable drilling on this deposit and has also made extensive concentration and smelting tests on two 5000-ton samples shipped out in 1958 and 1959. By grinding and magnetic concentration, the material can be raised to a product of about 60 per cent of iron while holding the TiO_2 to less than the 2 per cent present in the original material. The crude concentrates also carry around 0.2 per cent of V_2O_5 (vanadium pentoxide). The resulting material can be handled by special practices in a blast furnace, or by blending with other ores, but both are considered undesirable. Such titaniferous concentrates can be handled very satisfactorily, however, in an electric pig-iron smelting furnace. Possible methods of mining the deposit are under study.

(2) Klukwan Lode Deposit. Located as described above, this deposit is probably measured in hundreds of millions to a billion or more tons of titaniferous magnetite that contains around 15 to 20 per cent of iron and around 3 to 4 per cent of TiO_2. Results of the geologic studies and annual assessment work on the claims have not been made available, so reserve estimates are decidedly guesses, except that the deposit is huge in size. The material would require fine grinding and magnetic concentration prior to use.

(3) Port Snettisham Deposit. This is located about 35 miles southeast of Juneau on the northwest tip of the peninsula lying to the northwest of Tracy Arm (Figure V-1, No. 2). It is a huge low-grade magnetite deposit of the magmatic type, with the crude ore carrying about 17 per cent of iron with 3 to 4 per cent of TiO_2. It is reported to concentrate very well at 150 to 200 mesh, increasing the grade to 64 to 65 per cent of iron. The TiO_2 cannot be eliminated entirely in the concentration, but it is lowered from the 3 to 4 per cent

in the crude ore to 2.5 to 3.0 per cent in the concentrates. It is described in U. S. Bureau of Mines Report of Investigation 5195 (1955), but is said by one of the owners to be larger than shown in that report. No reserve tonnages were given therein, but one of the owners reports that it may exceed 100 million tons of concentrates, indicating crude-ore reserves in the ground of over 400 million tons.

(4) Union Bay Deposit. Located on the northwestern tip of Cleveland Peninsula about 35 miles northwest of Ketchikan (Figure V-1, No. 3), this magmatic type of magnetite deposit is reported to be somewhat higher in grade than the others of the same type described above (18 to 20 per cent of iron) and about double the size of the Snettisham deposit. Titania content is about the same as the others. No reports have been written describing grade and reserves, but a detailed geologic description has been published that discusses origin of the deposit.[4]

(5) Small Contact-Metamorphic or Replacement Copper-Bearing Deposits. Many of the numerous higher grade magnetite deposits of this type scattered through the southern part of Southeastern Alaska may well be exploited in the next few years. Some of these have been operated in the past in an attempt to recover only the copper content that generally runs less than 1 per cent, with traces of gold and silver, and occasionally palladium. Each deposit is measured in terms of a few million tons of ore that usually varies between 40 and 50 per cent of iron. The copper content is objectionable for use of this ore as iron ore, but the high-copper portions are amenable to selective mining and concentration for sale as copper concentrate. Serious consideration is being given to concentrating much of the material mined, with the coarser, high-sulfur material for sale as sinter feed. These deposits are generally similar to those in southwestern British Columbia on Vancouver and Texada Islands, where selective mining and concentration of this type have been practiced. Deposits of this type that have received recent attention for exploitation as direct-shipping iron ore are:

(a) The Mt. Andrew-Mamie area on Kasaan Peninsula about 30 miles northwest of Ketchikan (Figure V-1, No. 5)

(b) The Poor Man deposit on Kasaan Peninsula (Figure V-1, No. 5)

(c) Jumbo Basin deposit (Figure V-1, No. 6)

(d) Duke Island deposit (Figure V-1, No. 7)

(e) The Bradfield Canal deposit (Figure V-1, No. 4).

The U. S. Geological Survey estimated late in the 1940's that total iron-ore reserves on Kasaan Peninsula might be of the order of 5 to 10 million tons of contained iron (10 to 25 million tons of ore). It is quite probable that once these deposits are developed and mined, substantial additional reserves will be found, as has been the case on Texada Island where initial reserves of 1 to 2 million tons have been increased to around 10 million tons.

Potential Uses and Markets to 1980

Consideration of future markets for iron ore from the region under study now must be confined to countries bordering the Pacific Ocean. United States (other than West Coast) and European markets will be amply supplied from present sources and from the new huge mining developments (past, present, or planned) in (1) eastern Canada, (2) Lake Superior (taconite), (3) Venezuela, (4) Brazil, and (5) Africa. In a summary release on iron-ore supplies issued by the American Iron and Steel Institute on December 31, 1958, the statement is made:

> "There is no scarcity of iron ore in the world. In nearly all Atlantic areas of the Free World enormous deposits of iron ore are found – in such vast quantities that no calculations of so-called 'reserves in the ground' are any longer of primary significance."

A casual look at tabulated iron-ore-reserve data published by the United Nations in 1955[5] is ample evidence for the above statement, especially in view of technological developments that have brought such huge tonnages of low-grade ore into the commercial category. Incidentally, the vast tonnages of low-grade ore in the Mt. Reid-Wabush Lake area of eastern Quebec were not included in the reserve figures given in the United Nations study.

Major outlets for the Alaskan iron ore must be pretty much limited to markets on the West Coast of the United States and in Japan – the only two centers of steel manufacture of any consequence in Pacific Basin countries that are deficient in local iron-ore supplies.

Kaiser Steel's needs for ore to feed their Fontana blast furnaces will probably be amply supplied from their own Eagle Mountain mine nearby for well over a decade, beyond which other supplies may be needed.

With continued industrial growth of the Pacific Coast states, there is bound to be a need for additional integrated steel plants with ore-reduction facilities in that area within the next 20 years. At least two large companies have been investigating iron-ore resources in countries along the Pacific Coast of the Americas for some time – presumably in connection with long-range plans for possible plant locations on the West Coast. One of these companies, the United States Steel Corporation, has announced its intentions to locate an integrated plant on the West Coast.

With respect to Japanese markets, a 1958 U. S. Foreign Service dispatch[6a] indicated that Japan had estimated required imports of 21 million tons of iron ore per year by 1965, with sources estimated as follows:

	Million Tons
India	4.5
Malaya	3.7
Communist China	2.3
Goa	2.3
United States	1.1
South America	1.1
Canada	1.0
Other countries and new sources in Philippines and Malaya	5.0

Japanese were also reported active in developing Chilean and Indian ore deposits and in negotiating with Communist China for ore supplies.[6a] More recently reports in the trade press indicate widespread Japanese interest in mine development or purchase of increasing amounts of iron ore from Malaya, various parts of Africa, and British Columbia. By 1980, Japan's requirements might well rise by another 50 to 100 per cent. Inspection of the United Nations iron-ore survey reveals that sources of iron ore are plentifully scattered in countries bordering the Pacific. Sizable reserves of high-grade ore and huge reserves of low-grade ore are known to occur in parts of nearby Manchuria not far from the Mukden railway, for example. It would be virtually impossible, therefore, to attempt to predict how firm a market there might be in Japan for Alaskan iron ores for 20 years in the future. A growing market exists there, however, and keen interest by the Japanese in the Alaskan ores has been shown for several years.

British Columbia has given serious consideration to the economics of producing steel for the modest needs of the western provinces[7] with economics apparently favoring use of scrap as raw material. Iron-ore resources are deemed ample, however, to supply such an operation over its amortization period. If the operation were based on ore, British Columbia's past ore-export market to Japan might well be shifted to other sources – possibly to Alaska. Decision of Consolidated Mining and Smelting Co. late in 1959 to produce 100,000 tons of steel from iron-bearing tailings from the Sullivan mill at Kimberley, British Columbia is an initial step to supply this local market.

There remain for consideration the possible markets for pig iron or perhaps steel ingots that might be produced by electric smelting and oxygen converting of the Alaskan ore, by use of the relatively low-cost potential hydroelectric power available in areas close to the Alaskan iron ores. Some consideration of this is being given by at least two of the companies interested in the Alaskan ores. Presumably markets could be found in the future either on the West Coast of the United States or perhaps in Japan if pig iron or steel can be made and sold profitably at an attractive price.

Possible Electric Smelting

In connection with possible electric smelting of iron ore, the Alaskan iron deposits have the advantage of:

(1) Location on or reasonably near protected deep salt water, affording accessibility to cheap transportation.

(2) Amenability to open-pit mining in a climate that will permit year-round operation with much more moderate winters than are found in the Lake Superior district, for example.

(3) Nearness to numerous sites for developing relatively low-cost hydroelectric power needed for mining, beneficiation, or smelting. The sites with large potentials (Taiya, Taku, and Stikine) that could support big electrometallurgical operations involve complications of international agreement for their development, together with serious problems in financing, but there are a number of smaller sites that include water storage within Alaska that could support large-size mining and milling operations, and a few that could support moderate-size electrometallurgical operations.

With respect to electric smelting of iron concentrates in the area, the minimum-size economic operation would probably be around 500 tons per day (175,000 tons per year) of pig iron or so-called semisteel. This would require around 30,000 kw of electric power for a combination rotary-kiln pretreatment plant and electric pig-iron furnace at an assumed 90 per cent load factor, including power needed for mining and beneficiation. This type of operation could fit the Snettisham deposit. Daily production of 500 tons of pig iron would require roughly 925 tons of concentrates of 60 per cent iron content, assuming 90 per cent furnace recovery. At an 88 per cent recovery in beneficiation and a concentration ratio of 4 to 1, this would require about 3700 tons of 17 per cent ore per day. Assuming the smelter operated 350 days per year, and the mine and mill 300 days, daily output of the mine would have to be about 4350 tons per day, amounting to about 1.3 million tons of ore per year. Estimated ore reserves of several hundred million tons would supply such an operation for several hundred years.

The potential Snettisham hydro project, which combines power from Long Lake and Crater Lake about 20 miles to the northeast with about 32,000 kw of prime power, would be an attractive source for the electricity needed for such a project. Power cost estimates made by the Army Corps of Engineers(8) are around 6 mills at the plant, to which a little must be added for transmission costs.

A possible complication arises from the fact that this site has also been mentioned as a logical source of power for the newsprint-pulp mill under serious study by the Georgia-Pacific Company for location at Juneau. Sweetheart Falls, only a few miles from the deposit, could supply ample power for mining and concentrating at probably lower costs, but has insufficient capacity for either the Georgia-Pacific mill or for a 500-ton-per-day electric smelting plant.

The Yukon-Taiya power project would be the logical one to supply power needs for a substantially larger iron smelting project in the vicinity of the huge Klukwan fan deposit. A Bureau of Reclamation report(9) cited cost estimates based on January, 1951, prices at 2.1 mills per kwhr for a project to supply 340,000 kw in the first stage and 900,000 kw ultimate. Costs per kwhr at present prices might well be 25 to 50 per cent higher, but probably would still be below 4 mills per kwhr.

Let us assume a fairly substantial sized smelter producing about 3000 tons of steel per day (about 1 million tons per year of 350 operating days), using a rotary-kiln pretreatment plant and electric pig-iron furnaces, followed by oxygen converters. Power requirements for such a plant, including mining, beneficiation, smelting, oxygen generation, and incidentals, would be of the general order of 200,000 kw. This would be a substantial piece of the 340,000 kw available in the first stage of the hydro project.

Production of 3000 tons of pig iron (or steel) per day would require about 5500 tons of 60 per cent concentrates. With 10 per cent ore, and recovery of 90 per cent, this would take about 37,000 tons of ore per day, or about 13 million tons per year. Estimated reserves in the fan at Klukwan would be ample to keep such an operation going for well over 50 years.

The kiln pretreatment-electric smelting process assumed does not require coking coal in its operation. Coal from either the Matanuska or potential Bering River districts could be used. The 500-ton-per-day pig-iron operation would require about 75,000 tons of coal and 30,000 tons of limestone per year, and the 3000-ton-per-day operation would use about 450,000 tons of coal annually, plus 180,000 tons of limestone, in a 350-day working year.

One other possibility might develop for smelting the Klukwan iron deposits. Oil-drilling activities near Yakutat, along the coast some 140 miles westward from Klukwan, have indicated sizable gas shows, and additional drilling is planned there. Should a sizable gas deposit be found, there is the definite possibility of piping this gas to Klukwan via the Tatshenshini River and Haines Cutoff route, and smelting the iron concentrates by one of the sponge-iron processes such as the HyL, now being used successfully to smelt iron ore at Monterrey, Mexico.

Low-cost power for any such project at the Union Bay iron deposit is not available in sufficient quantities from separate intra-Alaska hydro projects. Any large iron-ore smelting project there might well have to await the development of power from the Stikine project in a joint Canada-United States undertaking, which is not visualized by Battelle during the next 20 years. Moreover, interest in developing the more easily mined fan deposit at Klukwan has been relatively greater than in exploiting the Union Bay lode deposit.

In summary, Battelle concludes that mining and concentration of iron deposits in Southeastern Alaska might well develop within the next 20 years, with annual output of ore or concentrates of the following order of magnitude as a reasonable estimate:

	Annual Output, short tons
Snettisham	325,000 (concentrates)
Klukwan (fan)	2,000,000 (concentrates)
Kasaan Peninsula deposits	600,000 (ore and concentrates)
Total	2,925,000

It would appear to be feasible to forecast smelting operations at Snettisham and Klukwan within 20 years, provided hydro plants are constructed by other parties to supply the low-cost power needed. There is no chance that steel or iron-ore companies would consider such operations if they had to supply the capital needed for construction of the costly hydro projects.

If such power is provided, it appears feasible to forecast operations that might produce around 1 million tons of pig iron or steel at Klukwan annually and around 175,000 tons at Snettisham.

The Kasaan deposits contain insufficient proved ore to consider their use for local electric smelting, nor is sufficient power potentially available in that area for this purpose.

Transportation Needs

Being directly on or close to tidewater, all the iron development projects need only ocean shipping to provide raw materials and supplies, and to ship their products. Docking facilities would have to be built, of course, but these would normally be provided by companies exploiting the resources.

Estimated potential outgoing tonnages of products have been given above which total around 3 million tons of iron ore or concentrates, or a total of around 1,175,00C tons of pig iron or steel plus, say, 600,000 tons of ore concentrates. Concentrates or steel from Klukwan are visualized as moving to the West Coast of the United States; ore or concentrates from other deposits largely to Japan; and pig iron from Snettisham to either Japan or the West Coast of the United States.

Inbound shipments would be heavy during construction work on the projects, but would drop off to modest amounts of general cargo to supply the plants, once in operation, plus the needs of the population required to operate them. Smelting operations would require inbound annual shipments of 75,000 tons of coal and 30,000 tons of limestone at Snettisham, and 450,000 tons of coal and 180,000 tons of limestone at Klukwan.

Potential Impact on Economy

The potential impact of the projected iron-ore mining, beneficiating, and smelting operations on the economy of Southeastern Alaska would be substantial, indeed. With the size and nature of operations so highly conjectural as they are at this stage, any estimates of employment, payrolls, etc., that might be involved are equally speculative. Assuming, however, that the Snettisham and Kasaan operations would be open-pit mining, with general labor productivity comparable to the 1953 open-pit average for Minnesota, about 65 workers would be needed for mining at Kasaan, and perhaps 140 at Snettisham. Beneficiation would require perhaps another 50 men at Snettisham. Conversion of the Snettisham concentrates to pig iron in a combination kiln-electric furnace plant would probably require an additional force of close to 200 men.

The larger size operation visualized at Klukwan would be more difficult to judge in terms of labor requirements – especially for the mining operation. This is because the method of mining is so highly conjectural. If dredges could be used effectively, the manpower requirements would be lowest. But at any rate, to produce 37,000 tons of material per day would probably require of the order of 500 men plus some 200 in the mill and shops. The smelter would require around 800 additional men to turn out around 3000 tons of steel per day. Total labor force for turning out ore and concentrates in the three areas would approximate 900 to 1000, with maximum about double this figure if the concentrates were converted to pig iron at Snettisham and to steel at Klukwan.

If we assume a value at the mine or plant of say 16 cents per long ton unit of iron (22.4 pounds) in the ore or concentrates shipped, and say $50 per net ton for pig iron and $70 per net ton for ingot steel, the annual values would be of the order of:

	Annual Value
Kasaan	
600,000 short tons ore (50 per cent iron)	$ 4,280,000
Snettisham	
325,000 short tons concentrates (60 per cent iron), or	2,780,000
175,000 short tons pig iron	8,750,000
Klukwan	
2,000,000 short tons concentrates (56 per cent iron), or	16,000,000
1,050,000 short tons pig iron, or	52,500,000
1,050,000 short tons steel	73,500,000

Minimum value of products on the above assumptions (ore and concentrates only) would total about $23 million, and maximum by conversion to pig iron and steel would come to about $86 million per year.

Smelting operations would require a total of over 500,000 tons of coal and 200,000 tons of limestone annually, all of which could be supplied from Alaskan sources, providing more year-round employment and product values.

Development of the iron ore deposits in the Hines Creek Area of Alberta is considered probable within the period 1960-1980, including production of around 350,000 tons of steel annually from the mining of around 1.5 million tons of ore. This might well utilize low-cost electric power from the planned Peace River hydro development in a combined pretreatment-electric smelting operation to produce pig iron, followed by use of oxygen converters to produce steel. The low-cost natural gas in the region might be used as an alternative reductant in the smelting operation. Nearby coal deposits could contribute.

Such an operation would employ an estimated 200 men in the mine and mill, and 300 in the smelting operation.

Copper

Past Production

Past output of copper from the Area was featured by the fabulously rich ore mined at the Kennecott mine in Alaska (Figure V-1, No. 26). From 1911 to 1938 this famous mine produced some 5 million tons of ore averaging 12.7 per cent of copper, yielding about 600,000 tons of copper sold, having a total value of around $200 million. Additional substantial amounts were produced in the early decades of the century from mines in the Prince William Sound area and in southern Southeastern Alaska.

Since 1941, value of copper output from Alaska has been less than $10,000 annually (Table V-1), and none has been reported from Yukon Territory. British Columbia produced minor amounts from 1939 through 1945, then jumped to between 1,246 and 2,650 tons annually between 1952 and 1957 when the Tulsequah mill treated ore from the Tulsequah Chief and Big Bull copper-silver-lead-zinc mines in the Taku River region (Figure V-1, Nos. 41 and 42). Lower base-metal prices in 1958 caused the closing of this operation. There is now virtually no production of copper from the entire area.

Reserves

Copper occurrences are widespread throughout the region under study, as may be seen in Figure V-1, which shows locations of the better known deposits.

Alaska

A more impressive picture of widespread occurrence is given in the map of copper, lead, and zinc occurrences in Alaska[50b] prepared by the U. S. Geological Survey.

Twenhofel[10] has pointed out that the more promising copper deposits of Alaska are found in the following regions: Southeastern Alaska, Prince William Sound, Copper River-Yukon River region, Iliamna Lake, Kobuk-Noatak River, and the region around the upper White River valley near the Yukon Territory border. Brief descriptions of geological occurrences are given by Twenhofel and also by Fellows[11, 12] which will not be repeated here. Estimates of reserves, by regions, given in Circular 252, are summarized in Table V-2. Much attention has been given to the Orange Hill deposit (Figure V-1, No. 27), and all the reserves shown in Table V-2 for the Copper River-Yukon River region are represented by this large low-grade deposit. At the Survey's estimated average copper content of 0.4 per cent, it is far too low grade to approach commercial ore — now and undoubtedly for well over two decades in the future.

TABLE V-2. ESTIMATED RESERVES OF COPPER ORE IN ALASKA, BY REGIONS[a]

	Indicated		Inferred		
	Tonnage	Grade	Tonnage	Grade	Remarks
Southeastern Alaska (Numerous Deposits)	18,000,000[b]	Most less than 0.50 per cent of copper			
Prince William Sound (Numerous Deposits)	1,500,000	Slightly more than 1 per cent of copper	5,000,000	Slightly less than 1 per cent of copper	
Copper River-Yukon River Region (Orange Hill Deposit)	200,000,000	0.4 per cent of copper			Low values of molybdenum, gold, and silver

(a) Source: Twenhofel, W. S., "Potential Alaskan Mineral Resources for Proposed Electrochemical and Electrometallurgical Industries in the Upper Lynn Canal Area, Alaska", U. S. Geological Survey, Geological Survey Circular 252 (1953).

(b) Indicated and inferred.

Other deposits, not included in the estimates in Table V-2, are briefly described as follows:

(1) Ruby Creek, Kobuk River Region (Figure V-1, No. 20). This has received considerable attention by one of the large copper companies, including extensive drilling in the past four summer seasons. Area drilled is about 2000 feet long by 400 feet wide, comprising a brecciated reef zone in limestone mineralized with copper sulfides. Values are highly erratic, with many sizable rich sections revealed in drill holes, but with disappointing results in trying to establish lateral continuities. A rough generalization for the entire area drilled would give a total tonnage of around 100,000,000 tons averaging around 1.2 per cent of copper. Chadwick[13] described the geology and probable operating problems, concluding that capital and operating costs would average roughly 1.5 times those for a copper mine in, say, Arizona. Others have opined that this ratio should be higher.

As of mid-1960, the company was not ready to say whether or not a mine could be developed in, say, 5 years. Transportation would be a very serious problem in moving supplies into and concentrates out of the area, with Kotzebue Sound to the west open only 2 to 3 months out of the year. Necessary lighterage of 12 to 14 miles from shore to shipside would add further to shipping costs.

(2) Sumdum (Figure V-1, No. 21). This is located at an elevation of several thousand feet along the mainland coast across Endicott Arm from the abandoned village of Sumdum. It was prospected and drilled to a limited extent in 1959; an official of the company that did the drilling reported it as a massive sulfide deposit – perhaps as much as 30,000,000 tons – that would average less than 1 per cent of copper. The company does not consider it high enough in grade for exploitation under present market conditions. Its location directly on deep, protected tidewater is a favorable feature, but it would have to be mined by underground methods.

(3) Brady Glacier (Figure V-1, No. 25). Little is known of this except that it is a promising copper-nickel deposit that was diamond-drilled through the glacier in 1959 and was scheduled to be drilled more extensively in 1960 by another company.

(4) Iliamna Lake and Kasna Creek (Figure V-1, Nos. 28 and 29). Discovered in 1906, both these deposits have been known for many decades, with spasmodic development work having been done at subsequent intervals without any commercial production. Both are mineralized limestone belts of substantial size that probably average somewhat less than 1 per cent of copper. Several large copper companies have examined them in recent years, but are not impressed.

Yukon Territory

Copper occurrences in the Yukon appear to favor the area in the southwestern corner in and along the margin of the St. Elias Mountains. Relatively common occurrences of copper pebbles in stream beds in this area, known for many decades, along with large boulders and slabs of native copper, have attracted much prospecting in this area. Several mines in the Whitehorse copper belt (Figure V-1, No. 31) produced copper values of some $2.7 million between 1905 and 1920, and these deposits have been re-examined repeatedly since then but have been passed by as too small. Other more promising copper deposits discovered in the past decade are as follows:

(1) Quill Creek (Figure V-1, No. 30). Discovery of this massive sulfide deposit carrying as much as 8 per cent of combined nickel and copper created quite a rush in 1952. Extensive trenching, drilling, and underground development in the next several years delineated the ore body as containing only 737,000 tons of ore averaging 2.04 per cent of nickel and 1.42 per cent of copper, plus substantial values in cobalt, gold, and platinum group metals. Exploration was suspended because of small tonnages shown in lower levels of the underground development workings. The grade is attractive, but tonnage is too small for any sizable undertaking. In 1960 Japanese parties were showing active interest in leasing or purchasing the property.

(2) Johobo (Yukon Star) (Figure V-1, No. 32). Shipment of some 600 tons of high-grade copper ore from this property to Japan in 1959 has been reported. It occurs as branching 10-foot-wide massive veins high in bornite (copper-iron sulfide), with wall rock on each side of the vein running around 2 per cent of copper. More work was scheduled on this property, located close to the Haines Cutoff road, in 1960, and hopes were running high that this important showing could develop into a really large and rich property.

British Columbia

As already noted, most of the copper output in British Columbia in the past two decades came from the Tulsequah Chief and Big Bull Mines. The latter is now mined out, and since the Tulsequah Chief is predominantly a zinc mine it will be discussed under lead-zinc in the next section. Copper in known ore reserves at this property is probably of the order of 10,000 tons.

Brief descriptions of the better known copper occurrences in British Columbia are given below. With the exception of the Granduc, relatively little development work has been done to indicate size and grade of these copper occurrences.

(1) Granduc (Figure V-1, No. 23). Extensive drilling and underground development work up to 1956 has indicated close to 30,000,000 tons of ore grading about 1.8 per cent of copper, or a total of 540,000 tons of copper contained in the ore. Located in extremely difficult terrain some 25 miles northwest of Stewart, near and under a glacier, the problem of access has so far prevented commercial operation. Access could be either by a 15-mile tunnel to the southward, or down the Leduc and Chickamin Rivers to a terminal on Behm Canal. In 1954 Granduc considered construction of a narrow-gauge railroad over this route and marine dockage and warehousing facilities; temporary special-use permits were issued by the U. S. Forest Service for these facilities, but the company decided against this and requested cancellation of the permits. More recent underground development has reportedly increased the reserves, and more such work is planned for 1960.

(2) Scud River Deposits (Figure V-1, No. 22). Several copper occurrences of substantial size have been found in the Stikine River area some 40 miles north of the lower reaches of the Iskut River, indicating a "copper province" extending between Porcupine and Scud Rivers, possibly as far as More and Ball Creeks.[13] Others are known in the Mess Creek area southeast of Telegraph Creek and in the Tahltan-Sheslay Rivers area northwest of Telegraph Creek. The deposits near the Scud River are located some 15 to 20 miles above its junction with the Stikine, and are low-grade, disseminated deposits in granitic stocks – typical porphyry coppers. Several of these have had a fair amount of development work indicating large size (perhaps of the order of 50,000,000 tons each) and grades of around 0.9 per cent of copper or lower. Another source opines grades varying between 0.75 and 1.50 per cent of copper. They appear to be just in the submarginal range, but additional development work might prove them to be better.

To be of real interest, one company reported that big deposits in that area should be over 1 per cent of copper. Another company with interests in the region reported that access difficulties are discouraging further development work, and that more drilling and development would be done if there were assured plans to construct a road up the Stikine River. Transportation by river boat up the Stikine is now limited to about 7 months of the year (early May to early December). If and when such a road were constructed to join the Stewart-Cassiar road, transportation would, of course, be down to tidewater rather than inland.

Within this general region there may well be many millions of tons of contained copper in these low-grade porphyry-type deposits, but much more work is needed to define more accurately their size and grade, and, hence, the economic feasibility of their commercial development.

The other copper occurrences shown in British Columbia in Figure V-1 (Toad River, Magnum, Pesika Creek, and Jane Group) represent relatively small showings on which varying amounts of sampling and drilling have been done. Descriptions of earlier work on Pesika Creek were given by McLearn and Kindle.(15, 16) Insufficient work has been done to appraise the potentials of these properties, but access is difficult for the latter three.

Potential Uses and Markets to 1980

Trends in the United States copper industry from 1910 to 1958 are shown in Figure V-2. The explosive increase in apparent domestic consumption of new copper between 1938 and 1941 to a peak of over 1.6 million tons is an outstanding feature, with World War II demand holding at around 1.5 million tons. The Korean War stopped the downward trend in the late '40s, since when the trend has again shown a slackening tendency to around 1.2 million tons. Addition of old copper scrap to this consumption picture would increase the figures by between 400,000 and 500,000 tons per year during the past decade.

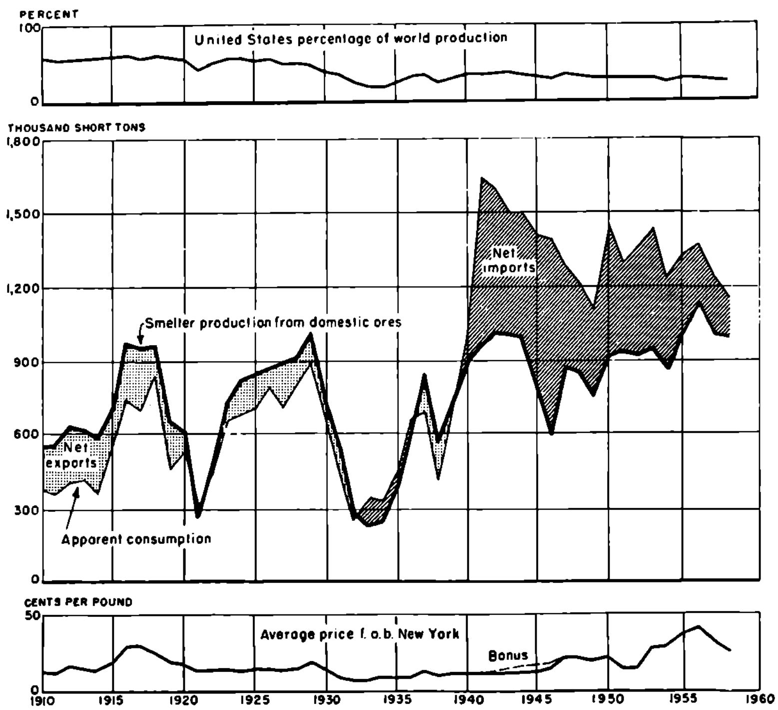

FIGURE V-2. PRODUCTION, CONSUMPTION, AND PRICE OF COPPER IN THE UNITED STATES, 1910-1958

Source: Minerals Yearbook 1958, U. S. Bureau of Mines, Vol 1, p 374.

Projected U. S. demand for total copper in 1975 by the Paley Commission was 2.5 million tons, including 0.7 million tons from old scrap. Early in 1960 a copper-industry official projected consumption of refined copper to 2.4 million tons in 1975.(17) This actually represents a greater projected increase than that made by the Paley Commission, because consumption of refined copper in 1950 was some 300,000 tons less than the 1950 base of 1.73 million tons' copper consumption used in the Paley projection.

Other Free World demand in 1975 was estimated by the Paley Commission at about 2 million tons. Vuillequez(17) projects it at about double this figure, reflecting the strength of demand growth abroad during the past decade. Continuation of this trend to 1980 would bring total Free World demand for refined copper to over 7 million tons in 1980.

From the stiff competition with substitute materials suffered by copper in the past decade and facing it in the future – especially from aluminum, but also from plastics – it would appear that projections of U. S. consumption in 1975-1980 may be on the high side. The expanded research and promotional efforts recently undertaken by the industry will have to produce effective results fairly quickly to raise the consumption trend in the U. S. sufficiently to double the figure between 1958 and 1975-1980.

It would appear that a reasonable projection for 1980 demand for new copper in the U. S. would be around 2 million tons, and for other Free World countries around 3.5 million tons – a total of 5.5 million tons of new copper.

Capacity of U. S. mines in 1959 was estimated(18) at 1,195,000 tons, with planned increases raising this to 1,290,000 tons in 1963. Capacity in other Free World countries in 1959 was 2,479,000 tons, with planned increases to bring this up to 2,949,000 tons in 1963. Free World total capacity for 1959 was thus about 3,680,000 tons and is estimated for 1963 at about 4,240,000 tons. This is considered to be somewhat in excess, both for U. S. and other Free World countries, of present and 1963 projected demand for new copper.

Industry representatives have opined that increased supplies from presently known world sources will take care of increasing demands for the next 10 to 15 years, but that new discoveries or major extensions of existing mines will be needed to meet mounting demands thereafter.

In judging the possible marketability of copper from ores in Northwest North America, it must be kept in mind that potential mines there must compete for the mining companies' funds for new development with potential mines in all other areas of the Free World. Size and grade of deposits, capital and operating costs, and comparative capital risks are major factors influencing decisions.

To get a rough picture of average grade of ores in world reserves, the following tabulation is taken from U. S. Bureau of Mines "Commodity Data Summaries – Minerals and Metals", February, 1959.

Country	Reserves: Quantity, Copper Content, million tons	Reserves: Grade, per cent of copper
United States	32	0.80
Chile	46	1.97
Peru	13	0.91
Northern Rhodesia	22	3.71
Canada	7	1.70
Belgian Congo	10	4.00
Other Free World	14	2.00
Soviet Bloc	16	2.20
Total	160	Average 2.03

In the U. S. in 1958, small tonnages of direct-smelting copper ores yielded an average of 4.78 per cent of copper, and milling ores (virtually the entire output of copper) yielded an average of 0.77 per cent of copper. Grade of ore mined was higher than this, of course, since losses of some 7 to 10 per cent are involved even in best milling practices.

Rough indications of competition faced by potential copper projects in Northwest North America are given in the following tabulation, showing size and grade of ore reserves for a few recent major new copper-mine developments:

	Ore Reserves, short tons	Grade, per cent of copper
Campbell Chibougamau (Quebec)	7,150,000	2.62
Timagami (Ontario)	100,000	13.0
Toquepala (Peru) (three districts close together)	1,000,000,000	1.0
Rio Blanco (Chile)	116,000,000	1.6
El Salvador (Chile)	375,000,000	1.5
Northern Rhodesia	2,000,000	4.8
Christmas, Arizona	20,000,000	1.83
Esperanza (Arizona)	49,000,000	0.75
Copper Rand Chibougamau	824,000 (above 525-ft level)	2.83

Prices for copper will have an important bearing on possible future exploitation of copper resources in the area under study. Long-term projections are hazardous and conjectural, at best, but in a comprehensive analysis Shea[19] concludes that "an average price of 30 cents [per pound] will be sufficient to cover all operating costs and at the same time provide a reasonable margin of profit for most copper producers" in the period 1960-1975. However, he assumes industrial use of refined copper in the U. S. in 1975 at around 2 million tons and total world (including U.S.S.R. and satellites) at 5 million tons. These would project to around 2.2 million tons for the U. S. and 5.4 million for the world in about 1980 – about the same as projections for new copper of 2 million tons for the U. S. and 5.5 million tons for the Free World assumed in this study. Vuillequez[17] concludes, however, that the price required to encourage the production of copper to be found in the future to supply the increasing demand "will probably have to be higher than 30 cents per pound unless, of course, a huge new very low-cost copper area is discovered". He points out, appropriately, that the capital costs of bringing new properties into operation, including mills and smelters, "are not on the way down, and the price of copper will have to reflect them and the other costs of producing, financing, and distributing copper, plus a profit on the investment".

Summarizing the marketability picture for copper ores from the region under study, it would appear that large deposits averaging 1 per cent or more of copper on or near tidewater might be good enough to develop in the period 10 to 20 years hence. This might be advanced in time if foreign political conditions in present large copper-producing countries develop unfavorably for continued production and expansion of copper operations. Northwest North America does offer an attractive political climate with minimum risk of prohibitive taxation and virtually no risk of expropriation actions to which foreign operations may be subject in many other parts of the world. Deposits in the region that are found at greater distances from tidewater will have to be of substantially higher grade in order to bear the higher costs of transportation to markets, even if roads are built to them.

Best chances for development of presently known deposits would appear to be: (1) Sumdum, (2) the Stikine River porphyries, (3) Kobuk, and (4) Granduc. Assuming further development would indicate reserves at each of the first three of the order of 50 to 100 million tons of 1 per cent of copper*, an economic size operation might be of the order of 10,000 tons of ore per day, producing 360 tons of concentrates running around 25 per cent of copper (assuming 90 per cent recovery with the copper mainly in chalcopyrite), or 90 tons of contained copper per day. In a 300-day year this would amount to about 27,000 tons of contained metal annually. A 50-million-ton reserve would insure operations at this rate for some 17 years. It is quite plausible to think in terms of world copper markets absorbing the output of as many as four operations of this size in the period starting, say, after 1970. This could perhaps comprise Sumdum, Kobuk, and two operations in the Scud River area of the Stikine River region. It is also plausible to consider world copper markets absorbing the future output of Granduc, operating at say 10,000 tons of ore per day.

The Sumdum deposit lies within some 25 miles of the excellent hydroelectric power site at Sweetheart Falls, which with estimated installed capacity of 22,000 kw and prime capability of 14,500 kw, would supply enough prime power to operate mines and beneficiation plants of both the Snettisham iron deposit and the Sumdum copper deposit.

The Kobuk deposit lies within 25 miles of the potential site on the Kobuk River shown by the Corps of Engineers in their 1959 report which would supply 11,000 kw of prime power – ample for operating a mine and mill with daily capacity of 10,000 tons of ore daily.

The Scud River deposits lie some 50 miles north of a potential dam site on the Stikine River some 10 miles from its mouth that could provide much more power than needed for mining and milling ore from the two operations assumed near the headwaters of the Scud. However, such a hydro development would involve an international agreement with Canada and might well impose more difficult and costly road construction up the Stikine and Iskut Rivers.

*It is quite likely, however, that economic operation of Kobuk may require an average grade of ore of 1.5 to 2.0 per cent of copper.

Transportation Needs

For the development of Sumdum, nothing would be needed except dock facilities to handle shipments of around 9000 tons of concentrates per month (one boat load).

Development of the Scud River deposits would require a good highway down the Scud and Stikine Rivers a distance of some 150 miles to deep water in the southern part of Mitkof Island, for the transportation of around 700 tons of concentrates per day or, say, 18,000 tons per month. Companies interested in the area have confirmed that movement of concentrates out of and supplies into the region would be westward to and from the coast rather than inland and southward via any potential highway or rail connection.

The transportation needs for possible development of Kobuk are much more conjectural. Located about 150 miles east of Kotzebue Sound and about 300 miles northwest of Fairbanks, the district has a serious accessibility problem. There is serious doubt, in fact, whether any means of transportation would prove economic for moving copper out in the form of concentrates, so search will be made for possible coal occurrences nearby to permit local smelting of the concentrates and shipment of blister copper. A road from Kobuk southwestward to a suitable harbor on Norton Sound would be necessary to freight in supplies and ship out copper if the deposit proves rich enough to make a mine.

Development of the Granduc property would require access by a local road up the Chickamin and Leduc Rivers from Behm Canal, as indicated earlier.

Potential Impact on Area's Economy

If and when five copper operations of these assumed sizes were developed, the impact on the Area's economy would be substantial. Assuming average labor productivity for copper ores cited by the Bureau of Mines of 2.21 tons of ore per man-hour average for 1947-1949[20], adjusted to 1958 by the index 161.9[6b] (1947-1949 equals 100), the 1958 figure amounts to about 3.6 tons per man-hour or about 29 tons per man day. An operation of 10,000 tons per day would thus employ about 350 men in the mine. The mill and shops would require roughly another 100 men.

Table V-3 shows a summarization of output and employment, including families and service needs of mine and mill employees at the five potential copper operations just discussed. Total population increase, including families and persons in service trades with families, might number over 2500 at each operation.

Value of the contained copper in concentrates annually from each of such operations (90 tons per day for a 300-day year at 30 cents per pound) would amount to around $16,000,000.

TABLE V-3. ESTIMATED OUTPUT, LABOR FORCE, AND POPULATION INCREASE AT FOUR POTENTIAL COPPER-MINING OPERATIONS IN ALASKA AND BRITISH COLUMBIA

Location	Estimated Reserves, million tons of ore	Grade of Ore, per cent of copper	Tons of Ore Daily	Tons of Concentrates		Hydro Power Available	Labor Force		Total Population Including Service Trades and Dependents
				Per Day	Per Month		Mine	Mill	
Sumdum	30 [a]	1 [a]	10,000	360	9,000	25 miles	350	100	2700
Kobuk	100	1.5 [b]	10,000	540	13,500	25 miles	350	100	2700
Scud River A	50 [a]	1 [a]	10,000	380	9,000	Doubtful	350	100	2700
Scud River B	50 [a]	1 [a]	10,000	380	9,000	Doubtful	350	100	2700
Granduc	30	1.8	10,000	650	16,000	Possible	600	100	4200

(a) Highly conjectural.

(b) Grade probably required to make operation economic, which is higher than that shown by drilling through 1959 season.

Lead-Zinc-Silver

Since lead, zinc, and silver usually occur in close association with each other in ore deposits, they will be discussed as a group. Silver also frequently is associated with gold, either in lode or placer deposits. The amounts of each of these metals occurring in a given ore deposit will vary widely, of course, but in the types of deposits found in Northwest North America they most frequently occur together in significant amounts.

Except for the rich ores of United Keno Hill in the Yukon, however, the quantities of these metals produced in the entire area in the past 20 years have been relatively insignificant. The potentials in Alaska, Yukon Territory, and British Columbia will be discussed briefly for each of these geographic areas.

Past Production and Reserves

Alaska

Table V-1 shows that annual lead production has never exceeded 1000 tons in the period 1939-1959, with value having exceeded $100,000 in only one year. Output since 1950 has been virtually nil. The record for zinc is even lower, with recorded production since 1939 having been shown for only the years 1947-1950, when output amounted only to small token shipments. Most of the silver produced in Alaska has come as a by-product of gold operations – virtually all of it in recent years from gold placer operations. For the past decade output has varied between 22,000 and 53,000 ounces valued at $20,000 to $48,000. Production has been falling off steadily along with that of gold.

Occurrences of lead-zinc-silver deposits are scattered widely in Alaska, as evidenced on the U. S. Geological Survey map[50b] of occurrences of these metals referred to in the copper section above. However, with the exception of the Mt. Eilson deposits in the Kantishna district north of Mt. McKinley, virtually all the deposits having any significance are in Southeastern Alaska. Most of the known zinc ores of Alaska are of the ferriferous sulfide type known as marmatite[10a] instead of the comparatively pure zinc sulfide, sphalerite; this feature contributes to a lower grade and complicates extractive metallurgy processes.[21a] Reserve tonnages for major districts given below are taken from Twenhofel.[10b]

The Mt. Eilson deposits (Figure V-1, No. 40) contain an estimated 200,000 tons of ore reserves carrying about 5 per cent of zinc, from 3 to 5 per cent of lead, and from 0.2 to 0.3 per cent of copper.

The lead-zinc deposits of the Groundhog Basin district on the mainland east of Wrangell (Figure V-1, No. 44) are the largest known in Alaska. Reserves there have been estimated by the U. S. Geological Survey at 550,000 tons of indicated and inferred ore containing 8 per cent of zinc and 1.5 per cent of lead, plus about 500,000 tons of much lower grade ore averaging 2.5 per cent of zinc and 1 per cent of lead. Limits at depth and to the northwest have not been defined, so future exploration may well result in increasing these reserve figures. The U. S. Geological Survey estimates that deposits in the entire Wrangell district (Groundhog Basin, Glacier Basin, Berg Basin, and Lake Claims) contain more than 80,000 tons of zinc plus 30,000 to 35,000 tons of lead.[12a]

The Tracy Arm deposit (Figure V-1, No. 43) contains an estimated 40,000 tons of ore per 100 feet of depth averaging 3.9 per cent of zinc and 1.5 per cent of copper. A similar small deposit at Moth Bay on Revillagigedo Island contains an estimated 100,000 tons of ore averaging 7.5 per cent of zinc and about 1 per cent of copper. A few other deposits are smaller and lower grade.

A lead-silver lode occurrence a short distance south of Ruby was being trenched and sampled by the U. S. Bureau of Mines in the summer of 1960, with encouraging results.

Yukon Territory

Lead-zinc-silver production has come almost entirely from the Mayo district, where the United Keno Hill operation has operated successfully for many years. Early operations in the district were confined to gold placer mining which followed shortly after the Klondike was opened. Lode mining from the silver-lead veins of Galena and Keno Hills started in 1912, and the record since then has been one of almost continuous production.[2b] Table V-1 shows the lead-zinc-silver output for the Yukon for 1939-1958. Figures jumped substantially in the late 1940's, and in recent years the annual output has hovered around 12,000 tons of lead, 8000 tons of zinc, and 6 million ounces of silver, plus around 100 tons of cadmium. The high silver content of around 40 ounces per ton of ore mined is the predominant value that makes the operation economic.

Principal lead-zinc-silver occurrences in Yukon Territory will be briefly described below.

(1) United Keno Hill (Figure V-1, No. 47). With a long record of successful operation, the outlook for the future of this enterprise appears very favorable. Even though proved ore reserves in 1959 were only 550,000 tons[22], prospects for downward continuation of ore appear good, and chances of finding additional deposits in the general vicinity also appear favorable. Reserves at this operation have never amounted to more than 1 to 3 years' output. The present reserves average 6.6 per cent of lead, 4.89 per cent of zinc, and 38.21 ounces of silver per ton.

Milling rate is about 500 tons per day or about 175,000 tons per year, yielding in fiscal 1959 about 16,000 tons of lead concentrates averaging 71 per cent of lead, and 13,800 tons of zinc concentrates averaging 64.5 per cent of zinc, plus about 6.8 million ounces of silver (largely in the lead concentrates). At the present rate of mining and milling, the reserves amount to about a 3-year assured supply. Driving of a lower-level adit toward the ore zones, started in 1959, should be completed in 1960; results of development at this level should indicate more clearly the longer-term outlook for future operations of this enterprise.

About 500 men are employed at the operation[23], and basic wage scales are at reasonable levels of around $1.70 to $2.25 per hour.[24]

Concentrates are trucked from Keno Hill to Whitehorse, thence shipped by White Pass and Yukon railroad to Skagway, by ship to Vancouver, thence by rail to Trail or other smelters in the Pacific Northwest.

(2) Vangorda Creek (Figure V-1, No. 48). Located some 35 miles northwest of Ross River on the east side of Pelly River, this is a relatively large deposit of about 10 million tons that averages 4.84 per cent of zinc, 3.05 per cent of lead, 0.3 per cent of copper, 1.84 ounces of silver, and 0.02 ounce of gold per ton.[25] The deposit is high in sulfides, running about 50 per cent of pyrite. The property is held by Prospectors Airways Company, Limited, who have performed considerable development work on it.[26]

To make this a commercial venture, lead and zinc prices would have to rise. Consideration was given to mining and milling 2000 tons per day, involving a haul of 250 miles westward over a bulldozed trail to Carmacks and thence to railhead at Whitehorse. Hauling costs were estimated at 10 cents per ton mile in trucks or 6 cents per ton mile in diesel-electric truck-trains of six cars per train and 30 tons per car. Decision was made, however, to postpone operation.

(3) Hyland River (Figure V-1, No. 53). Held by American Smelting and Refining Company, this property lies about 50 miles northeast of Watson Lake, and was discovered around 1952. It contains an estimated 1,000,000 tons of ore averaging 4.9 per cent of lead, 9.5 per cent of zinc, and 4 to 5 ounces of silver per ton. Chances of extending the reserves are reported reasonably good. This would involve a truck haul of over 350 miles to railhead at Whitehorse. The grade is attractive, but size of reserves is too small to consider for a sizable operation. At only 500 tons of ore per day (150,000 tons per year) the reserves amount to only 7 years' operation.

(4) Macmillan Pass (Figure V-1, No. 51). Hudson Bay Exploration and Development found and drilled this deposit, known as the Tom Claims, located near Macmillan Pass on the old abandoned Canol road. It contains an estimated 10.5 million tons of ore averaging about 5 per cent of zinc plus low lead-silver values. It is much too low grade to be economic in its inaccessible location.

Other lead-zinc-silver deposits, many of which are not shown on Figure V-1 are scattered through the central, eastern, and southeastern parts of Yukon Territory. The moderately metamorphosed sediments accompanied by intrusives in this broad belt are considered to be northward geologic extensions of counterparts of highly mineralized areas in the Coeur d'Alenes of Idaho and around Kimberley, British Columbia (Sullivan mine). It is considered good country for prospecting.

British Columbia

Earlier production of lead-silver-zinc from the area near the head of Portland Canal (Anyox, Premier) has pretty much disappeared as many famous mines in this area were depleted. Recent development work in the Anyox mine is rumored to have yielded encouraging results, which might lead to resumed operations in the future. Most of the lead and zinc from northern British Columbia mined in the past decade (see Table V-1) came from the Tulsequah Chief and Big Bull operations of Consolidated

Mining and Smelting Company on the Taku River, shown in Figure V-1 (Nos. 41 and 42). The Big Bull operation was mined out and closed down in 1956. When the Tulsequah Chief closed down in 1957 as a result of lower zinc prices, ore reserves were reported to be some four times larger than estimated when the mine was opened, and about 1 million tons of ore had been produced in its 6 years of operation. Ore values are predominantly zinc, with lesser values in lead, copper, silver, and gold. Construction of a road up the Taku River might well tip the economics in favor of reopening this operation.

Many other scattered lead-zinc-silver occurrences are known in northern British Columbia, only a few of which are shown on Figure V-1. Of these, an occurrence of huge pieces of float (detached boulders) of solid galena carrying some 17 ounces of silver per ton was found by Conwest along Frog River (Figure V-1, No. 55). Efforts to find the ore body have been unsuccessful, but more work will be done on it in the next couple of years. Access is difficult.

A highly capable geologist with long experience in responsible positions in the region indicated to the writer only fair interest in northern British Columbia for future large mineral discoveries, averring instead that the region will yield many relatively small to medium properties, mainly of the lead-zinc-silver type.

Potential Uses and Markets to 1980

Brief indications of future uses and markets for lead, zinc, and silver will have to be discussed separately, of course, since use patterns, technology, and competition differs so markedly for each.

Lead. Figure V-3 shows trends in the lead industry in the United States, 1920-1958. Consumption includes primary refined, antimonial, and secondary lead plus lead in pigments made directly from ore. Major features are (1) the virtually flat level of consumption in the 1940's and 1950's; (2) the sharp rise in imports beginning in the late 1930's; and (3) the gradual drop in U. S. output as a percentage of world production.

Principal uses are in storage batteries, in tetraethyl lead as antiknock additive in gasoline, in cable sheathing, and in pigments.

The Paley Commission projected U. S. 1975 demand for lead (primary and secondary) at a total of 1,950,000 short tons, a 61 per cent increase over 1950. Industry, recognizing the strong competition ahead from other metals and materials, felt that this was much too high, favoring an increase tied more closely to estimated population growth. The record of annual lead consumption in the past decade throws doubt on whether it can even keep pace with population growth, since it has stayed virtually level between 1 and 1.2 million tons while population has increased some 18 per cent. The research program recently undertaken by the lead industry may well give the metal the pickup necessary to keep the demand rising in ratio with population growth. Based on estimated U. S. consumption of 1.1 million tons in 1959[27] and Bureau of Census estimates (Series III) of 245.4 million population in 1980 compared with about 177 million in 1959 (a 39 per cent growth), U. S. lead demand in 1980 is estimated at 1.5 million tons in 1980. Assuming secondary lead supplies 60 per cent of the demand, as estimated for 1960, the 1980 demand for new lead would amount to about 900,000 tons, an increase of 250,000 tons over the estimate for 1960. It is doubtful if foreign demand will rise at a

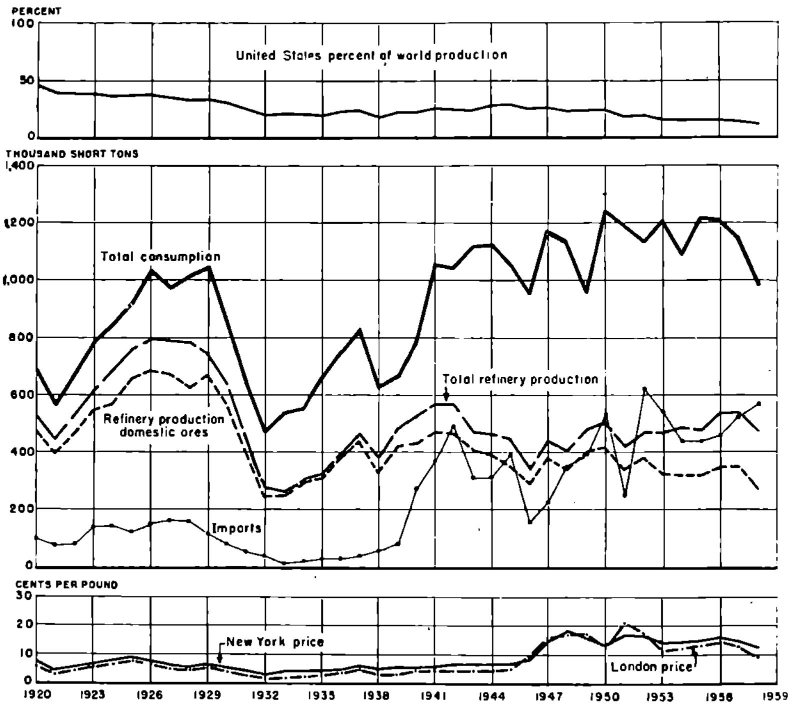

FIGURE V-3. TRENDS IN THE LEAD INDUSTRY IN THE UNITED STATES, 1920-1958

Source: Minerals Yearbook 1958, U. S. Bureau of Mines, Vol 1, p 638.

rate much faster than the U. S. projection. Davis(28a) projects world consumption of primary lead at only a slightly higher rate of increase than that for North American consumption. In view of known world reserves of almost 50 million tons of lead contained in ore, it would appear that future world demand for new lead can be pretty well supplied from exploitation of known reserves. Plans to develop the Bathurst zinc-lead deposit in New Brunswick and the Pine Point deposit on the south shore of Great Slave Lake will add considerably to lead output. Other major new or expanded lead-producing projects under construction, planned, or under investigation, include Sulfide Corporation and Mt. Isa in Australia; American Zinc at Mascot Tennessee; Bunker Hill at Torlon, Guatemala; and several companies at Enterprise, Utah, and at East Tintic, Utah.

From this review of the lead picture, therefore, the outlook for development of lead-bearing deposits in the area under study appears none too promising. It is quite possible, however, that a somewhat healthier outlook for zinc may bring a few known properties into production. And, if exploration were to uncover much richer lead deposits in the future – especially if silver values run high – such deposits might well become commercial producers rapidly.

Best chances for production in the next 20 years would appear to be from Vangorda (say, at 2,000 tons of ore mined and milled per day), and Hyland River (at 500 tons mined and milled per day*). Annual output of concentrates at these two operations would be of the order of 70,000 tons at Vangorda (300-day year), and 30,000 tons at Hyland River. Logical outlet would be by truck to Whitehorse, and by rail and water to Skagway, Vancouver, and Trail.

This could mean operations at Vangorda (open-pit mining) employing some 75 men in the mine and 50 in the mill, shops, and in transportation. The smaller operation at Hyland River might employ several hundred persons in underground mining and in mill and shops.

Zinc. Trends in the zinc industry in the U. S., 1920-1958, are given in Figure V-4. Major features shown are: (1) the moderately slow rise in consumption since the early 1940's, (2) the rise in smelter production from foreign ores since about 1940, and (3) the drop in U. S. percentage of world production from about 60 per cent in 1920 to about 25 per cent in 1958.

Galvanizing and die castings each account for around 40 per cent of slab-zinc consumption. Although both these uses have been and are being subject to competition from other materials in their manifold uses, zinc is holding its position reasonably well.

The Paley Commission projected U. S. demand for new zinc in 1975 at 1.5 million tons, a 39 per cent increase over the 1950 figure of 1.08 million tons. Like lead, the zinc-consumption picture in the U. S. has merely held a level path in the past decade. When viewed against the 16 per cent rise in population, consumption per capita has shown a steady decline. The expanded research program recently undertaken by the zinc industry may result in reversing this trend. But it would appear that zinc demand will do well if it only increases in accordance with estimated population growth in the period 1960-1980. Instead of projecting from the 1959 zinc-consumption figure of 962,000 tons,

*Lower production rate dictated by smaller reserves. If reserves could be increased to 5 or 10 million tons of ore, the daily output of ore could be assumed the same as Vangorda Creek.

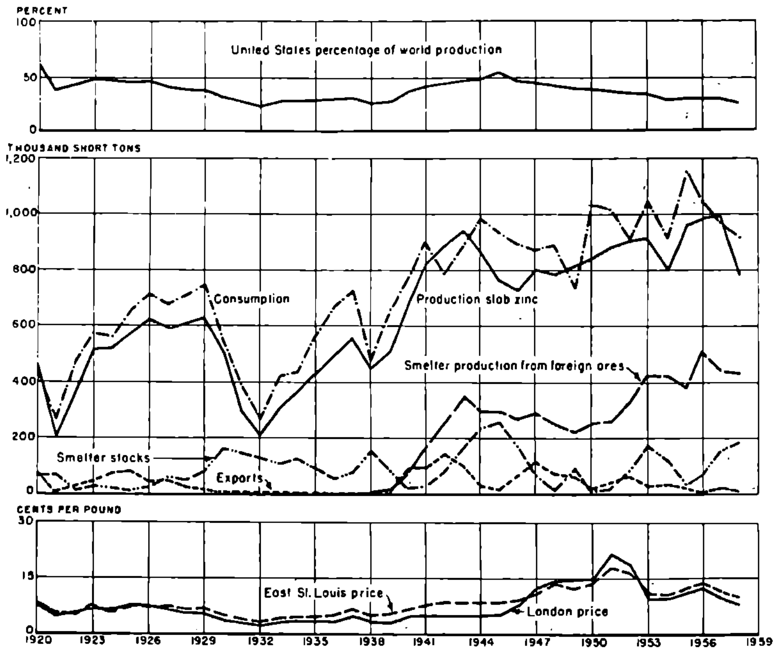

FIGURE V-4. TRENDS IN THE ZINC INDUSTRY IN THE UNITED STATES, 1920-1958

Source: Minerals Yearbook 1958, U. S. Bureau of Mines, Vol 1, p 1150.

which was on the low side because of the effect of the protracted steel strike on galvanizing, it is felt that a more realistic projection would be from the estimated 1960 consumption figure of 1.1 million tons.(29) Population in 1960 is estimated at 180 million, increasing to 245.4 million in 1980 - a growth of 36.4 per cent. Applying this percentage increase would bring 1980 consumption of slab zinc up to 1.5 million tons, precisely the figure projected by the Paley Commission for new zinc in 1975.

The Paley Commission projected other Free World demand for new zinc increasing 60 per cent between 1950 and 1975 to a total of 1.7 million tons. Adding the U. S. 1975 demand projection of 1.5 million tons gives a total of 3.2 million tons for the Free World in 1975. Davis(28b) estimates total world demand in 1980 at about 4 million tons, an increase of about 80 per cent between 1950 and 1980, but only about 33 per cent between 1955 and 1980. The U. S. Tariff Commission(30) shows world consumption increasing between 1950 and 1956 at a rate much faster than that for the U. S. Recognizing major conjectural features involved, we are inclined to project 1980 world demand at 4 million short tons of slab zinc, of which the U. S. demand will amount to 1.5 million short tons.

With regard to future supplies, the U. S. Bureau of Mines estimates world reserves of zinc ores as of January 1, 1957, as follows:

	Quantity of Contained Zinc, short tons	Approximate Average Zinc Content of Ores, per cent
United States	13,485,000	3.3
Canada	16,691,000	4.4
Mexico	6,650,000	6.6
Other Latin America	6,175,000	12.0
Australia	11,000,000	11.0
Other Free World	16,500,000	Not available
Soviet Bloc	14,000,000	Not available
World Total	84,501,000	Not available

To supply the moderately increasing U. S. and world demand for zinc, supplies from present known sources are ample for probably a decade or more, but new supplies will have to be found thereafter - especially to hold future reserves at a reasonable figure in terms of equivalent years' supply. In fact, the major trouble with the world zinc industry in recent years, as in lead, has been a case of excess capacity and excess production. Efforts have been made through the International Lead-Zinc Study Group to curtail world output, and U. S. producers for many years have made serious attempts to obtain congressional approval of various plans to give more effective protection to U. S. producers against competition from imports of foreign ores and metal. Early in 1960 it appeared doubtful that any immediate change would be made from the present system which since October 1, 1958, has limited imports of zinc and lead to 80 per cent of average annual amounts imported in the 5-year period 1953-1957, inclusive.

As with other metals, zinc prospects in Northwest North America must compete for mine development dollars with districts elsewhere in the world. A few typical examples of recent and planned new mine developments or expansions are as follows:

(1) Mattagami Lake, Quebec – some 22 million tons of ore averaging 12.7 per cent of zinc, 0.7 per cent of copper, 1.2 ounces of silver, and 0.02 ounce of gold per ton.

(2) Brunswick Mining and Smelting, New Brunswick – 58 million tons of ore averaging 5.3 per cent of zinc, 2 per cent of lead, 0.45 per cent of copper, and 1.7 ounces of silver per ton.

(3) American Zinc, Mascot, Tennessee – 400,000 tons-per-year increase (33 per cent) in mill capacity for 85-million-ton ore reserve averaging around 4 per cent of zinc.

Probably to be developed in the near future are the extensive zinc-lead deposits on the south shore of Great Slave Lake extending southwestward from Pine Point in a belt some 22 miles long by 2 to 4 miles wide. Much drilling was done in the early 1950's by Consolidated Mining and Smelting Company, who control the property. Earlier official estimates of ore reserves released by Cominco gave 5 million tons of open-pit ore averaging 7.4 per cent of zinc and 4 per cent of lead. Others familiar with the property have estimated that ore will run at least 100 million tons, and the potential of the district has been compared by many with that of the original Tri-State district in the U. S. In 1960 Cominco announced that reserves are comparable in size with those in the huge Sullivan mine at Kimberley, British Columbia. A 400-mile railroad is needed to exploit the property, and the Canadian government has had the Manning Commission studying the problem of location of such a railroad since June, 1959. In June, 1960, the Commission issued a report with divided opinions, and late in 1960 decision was made to use the western route and start an engineering survey of it.

Silver. Production and consumption of silver, in the U. S. and in foreign countries, have held at reasonably steady levels during the past decade. Industrial consumption is mainly in silverware, photographic materials, electroploating, and in brazing alloys; in the past decade U. S. consumption has varied moderately at levels slightly below 100 million ounces. World consumption in industry and in arts has been at steady levels at a little more than double the U. S. amount. Coinage takes another 30 to 40 million ounces in the U. S. and roughly a similar amount abroad. Price for many years has held reasonably close to the U. S. Treasury buying price (now 90.5+ cents per ounce) for newly mined domestic silver.

In 1959 extended strikes at major U. S. copper refineries substantially reduced silver supplies. This, coupled with strength in industrial and coinage demands, resulted in sizable sales of "free" silver from the U. S. Treasury. During 1960 many predictions were made of continuing heavy drains on U. S. Treasury silver to meet increasing demands, with depletion of limited "free" Treasury stocks in sight – all cited to support appeals for raising the U. S. Treasury price for newly mined domestic silver. Others have predicted that resumption of normal copper refinery operations would lessen the need for Treasury silver and result in continuation of the relatively stable price pattern of the past few years. Domestic output in 1960 continued a moderate decline due to protracted strikes in the Coeur d' Alene district and curtailed operations elsewhere. Any moderate rise in the price of silver would have little impact on Alaska's economy, but it might well result in expanded operations from the Mayo district in Yukon Territory and possibly stimulate exploration in northern B. C.

Future Outlook - Lead, Zinc, and Silver

In retrospect and summary, the future outlook for production of lead, zinc, and silver from the Area - except for hopeful continuation of Keno Hill at about present levels - appears none too bright, based on known occurrences of these metals. A medium-size operation at Vangorda appears to be the most promising, where perhaps several hundred men might be employed in operating an open-pit mine, mill, shops, warehouses, transportation, office, and stores. Output would amount to only some 250 tons of concentrates per day, that logically would move by diesel-electric truck-train or by truck to Carmacks and Whitehorse, thence by rail and boat to Skagway, Vancouver, and Trail, British Columbia. An operation of similar size in employment, but shipping less tonnage of concentrates, might also be visualized at Hyland River. Construction of a road up the Taku River might well tip the economics in favor of reopening the Tulsequah mine with an assumed output of around 30,000 tons of concentrates annually valued at around $5 million, and employing less than 100 men. Insufficient reserves are known in the Area to consider construction and operation of a smelter or refinery for any of these three metals.

Gold

Because of the relative ease of concentrating low values in ore and placer ground to a very high-value product, poor accessibility and distance from markets have not prevented rather full exploitation of the gold resources of the Area in the past. In fact, gold has accounted for probably at least two-thirds of the $2 billion worth of metals and minerals produced in the Area to date.

Production in Alaska, Yukon Territory, and Northern British Columbia for the years 1939-1958 is shown in Table V-1.

Alaskan output was severely damaged by the War Production Board's order closing gold mines in 1942, and recovered to only about one-third of its 1940 output. It held roughly at this annual level of around $8 million to $10 million until the late 1950's, when it gradually dropped back to about $6 million. Continually rising costs coupled with the fixed price since 1934 have combined to force the shutdown of more and more operations in the entire Area. Main placer-mining districts are shown on Figure V-5.

Production in recent years has been concentrated in (1) the Fairbanks area, (2) the Nome area, and (3) the Klondike area near Dawson. Dredges produced 80 per cent of the output in Alaska in 1958. It is interesting to note that the average value of gold produced per cubic yard from dredges dropped from about 62 cents in 1955 to 33 cents in 1958. Dredging operations in many parts of the area are made relatively costly by the necessity of muck-stripping and gravel-thawing ahead of dredging.

The largest gold operator in the Area announced[31] in 1958 that "it is expected that they (Fairbanks and Nome dredge operations) will not continue beyond 1963 or 1964". They have further stated:

> "When the shutdown occurs, most of the dredgeable ground at Fairbanks will have been exhausted but substantial areas of marginal ground will remain at Nome which might become profitable at a higher gold price. It is planned to hold the mining property so that operations can be resumed at some future date if conditions justify it."

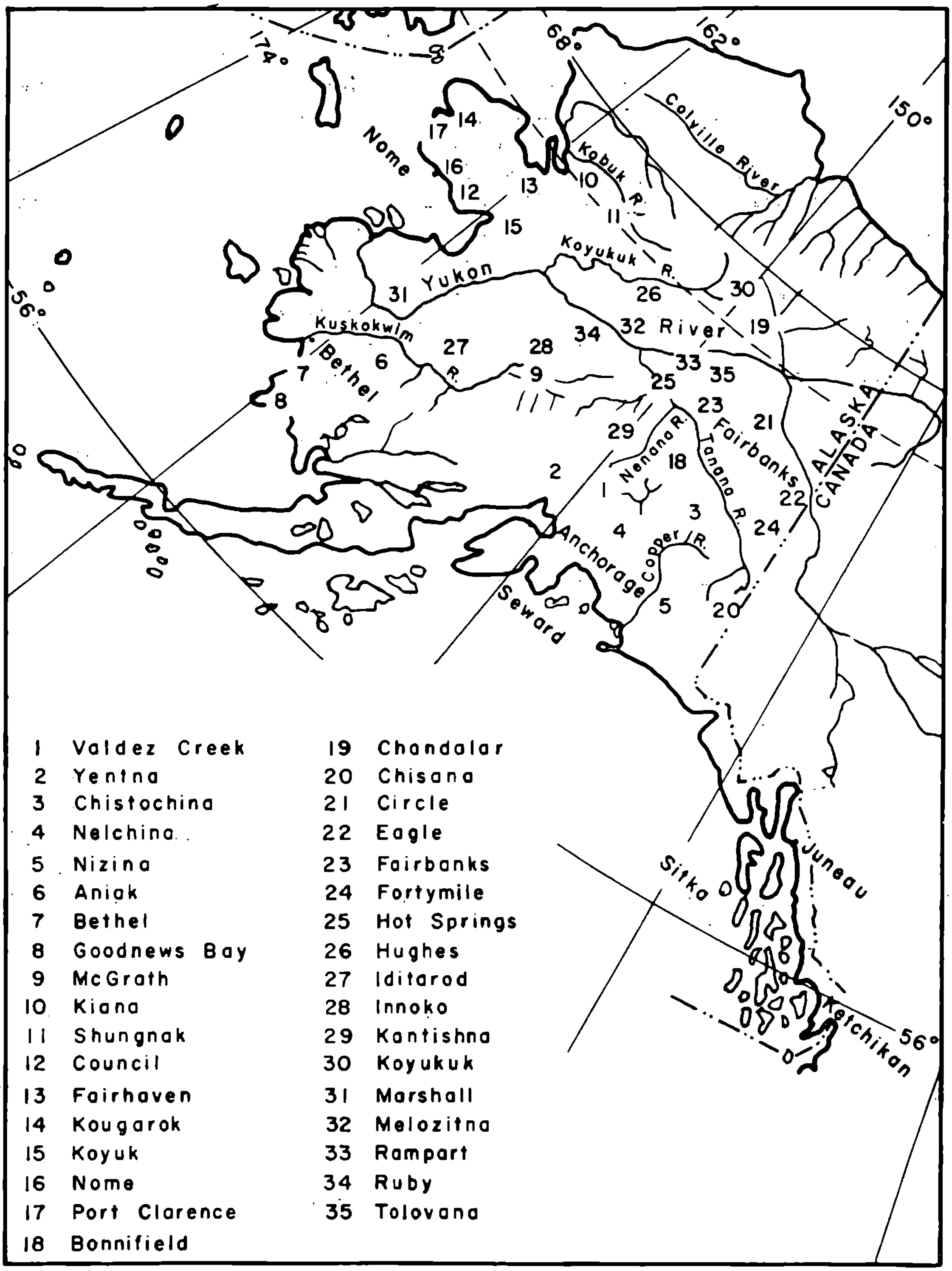

FIGURE V-5. PLACER-MINING DISTRICTS OF ALASKA

Source: U. S. Bureau of Mines, Information Circular 7926 (1959), p 19.

Conversations with company officials in 1960 confirm the above, but indicate the probability of the closedown for Nome in 1962 and a gradual cutting off of the Fairbanks operations by the end of 1963. Smaller operations may continue for some time at Chicken and Hog Rivers, but these are only of minor importance – similar to the small seasonal dredging operations in the Kuskokwim, Cold Creek, and Woodchopper Creek.

The largest dredge in the Klondike region has also ceased operations.

In summary, the outlook for gold mining, the mainstay of mining in the region throughout its history, is dreary, indeed. Even if the gold price were substantially increased – a highly conjectural matter at best – many of the largest operations would not resume because of depletion of their reserves. On the other hand, there can be little doubt that such a price increase would greatly spur smaller mine and placer operations, and serve as an incentive to search more diligently for larger lode occurrences. It would likewise benefit gold-bearing base-metal prospects in the Area, but the same benefit would accrue to all such competitive prospects throughout the world.

For the above reasons, future gold potentials have very little bearing as justification for improved transportation in Northwest North America.

Mercury

The only underground metal mine in Alaska producing substantial values with a fairly continuous production record in the past decade is the Red Devil mercury mine (Figure V-6, No. 30) near Sleetmute in the Kuskokwim region. Operations there were interrupted from late 1954 to early 1956 by a fire which destroyed most of the surface plant. Another very small operation has been conducted intermittently some 80 miles to the southwest by Schaefer (Figure V-6, No. 30). Considerable development work was done at the Red Top operation north of Dillingham (Figure V-6, No. 32) in the early 1950's with help from DMEA, but the operation proved uneconomic. DMEA assistance was also received in exploratory work at the Red Devil and De Coursey Mountain properties. Total production from Alaska since 1939 has amounted to around 20,000 flasks (76 pounds per flask), including estimates for a few years when output was not revealed. Table V-1 shows the record, by years.

Even larger output during World War II came essentially from one operation at Pinchi Lake in north central British Columbia (Figure V-6, No. 33), with a total output in 5 years of about 53,000 flasks. Small amounts came during the same period from the Takla mine north of Hazelton (Figure V-6, No. 34). Reserves of considerable size still occur in these properties, but operations are not profitable under present costs at current mercury prices.

Efforts to find additional mercury supplies during World War II included considerable development work by the U. S. Bureau of Mines and Geological Survey in Alaska. Earlier work had indicated promising prospects for mercury in the general Kuskokwim River region.[21b] Work on the Red Devil property showed considerable ore containing from 35 to 45 pounds of mercury per ton, far above that for all U. S. mercury mines, which over a long period has averaged between 5 and 10 pounds per ton.

Production soon got under way, and has been reasonably continuous ever since, except for a shutdown in 1950 and 1951, and again in 1955 due to the fire. Output in 1952 was revealed as 28 flasks from 70 tons of ore treated, which would indicate average ore grade of better than 30 pounds of mercury per ton. Conversations with the present operator indicate grade is holding at this level or even higher.

Ore reserves at this operation have never been developed much in advance of mining, but the deposits there have continued to yield high-grade ore as operations were continued. Mining costs alone are known to be far above the approximately $20-per-ton average for U. S. mines in 1956-1957 reported by the U. S. Tariff Commission.[32a] With the steady reduction in mercury prices from the average in 1955 of $290 per flask to the early 1960 level of around $212 per flask, most domestic mines have closed. This is not surprising when noting total production costs (mining, furnacing, taxes, administrative, etc.) for unidentified individual operations reported by the U. S. Tariff Commission[32b] for 1956 and 1957, which ranged from a low of $163 per flask to a high of $583 per flask.

With the ore grade at the Red Devil running over three times that of average operations in the U. S. (which at lower prices is probably closer to 10 pounds per ton in early 1960), and the operation reported to be approaching economic marginality, this is an outstanding example of the higher production and marketing costs to which interior Alaskan mine operations are subject, which require much higher ore grade than operations in the U. S. The mercury output is flown to Anchorage at a cost of about $4 per flask, thence to Seattle by barge at an additional cost of $3. 25 per flask. This adds considerably to the total cost of production and marketing.

In fact, one large domestic mine operator who has followed the Alaskan picture closely reported[33] that considering mining costs alone, for a small underground operation typified by mercury, costs in interior Alaska would run $50 to $60 per ton mined, in western U. S. they would be around $20 per ton, and in Latin America as low as $5 per ton. This is not necessarily typical of other operations as indicated by estimates for cost ratios of roughly 1. 5 to 1 between Kobuk and, say, Arizona copper mine operation as cited earlier in this chapter under "Copper".

Other promising mercury prospects that have received considerable attention are the De Coursey Mountain property (Figure V-6, No. 35) and the White Mountain property (Figure V-6, No. 36).

Trends in U. S. production, consumption, and price of mercury, 1916-1958, are shown in Figure V-7. Dependence on imports has been substantial since the relatively short period of virtual self-sufficiency during World War II. Consumption has held at a general plateau of around 50,000 flasks annually during the past decade.

With major usage in electrical apparatus, agriculture, chlorine and caustic manufacture, and industrial and control instruments, there appears to be little on the horizon to indicate future demand growth at more than a rate equaling population growth. A recent trend toward replacing diaphragm cells with mercury electrolytic cells for production of chlorine and caustic soda[34] may give a temporary boost to mercury demand in the next few years.

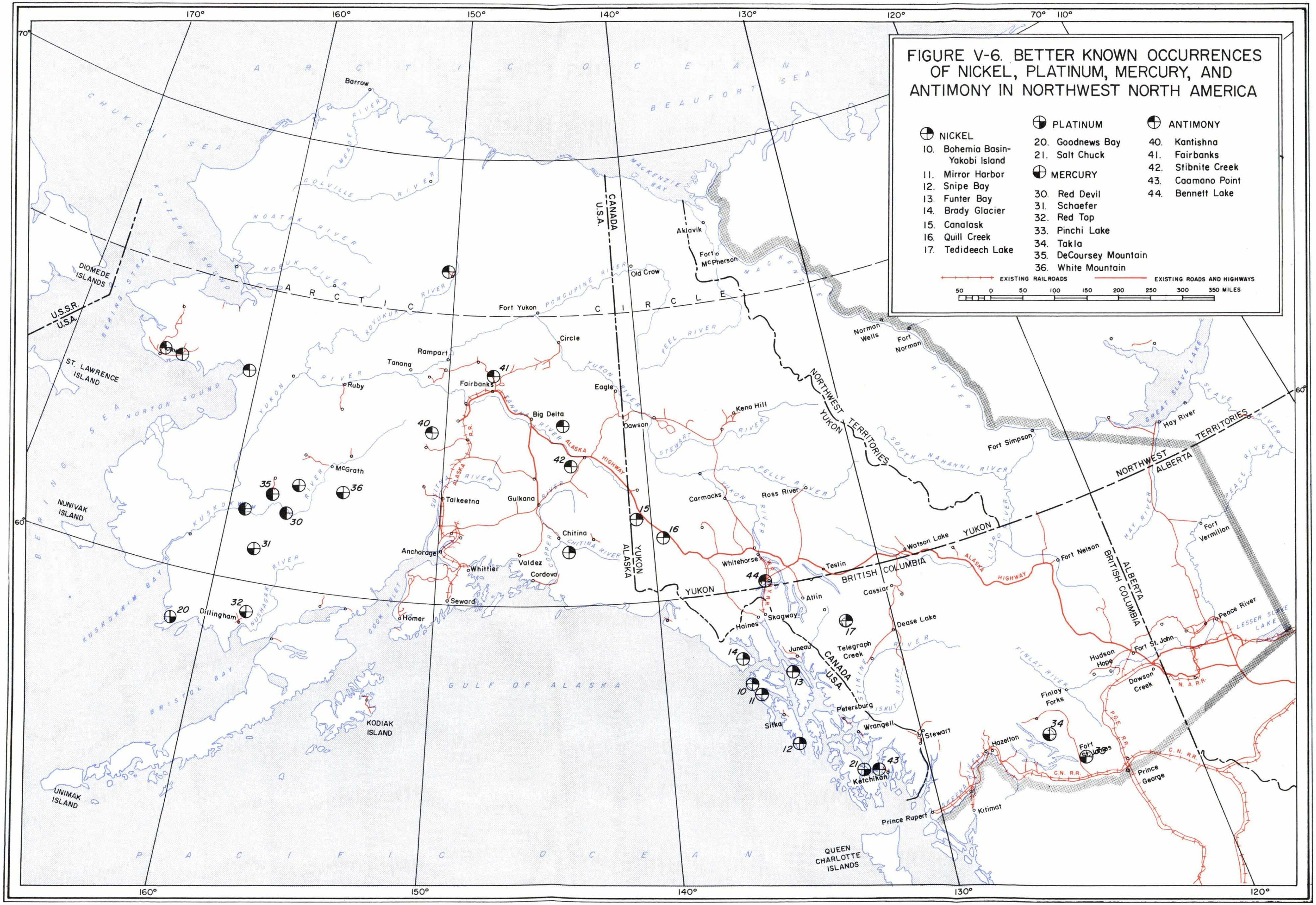
FIGURE V-6. BETTER KNOWN OCCURRENCES OF NICKEL, PLATINUM, MERCURY, AND ANTIMONY IN NORTHWEST NORTH AMERICA
NICKEL
10. Bohemia Basin-Yakobi Island
11. Mirror Harbor
12. Snipe Bay
13. Funter Bay
14. Brady Glacier
15. Canalask
16. Quill Creek
17. Tedideech Lake
PLATINUM
20. Goodnews Bay
21. Salt Chuck
MERCURY
30. Red Devil
31. Schaefer
32. Red Top
33. Pinchi Lake
34. Takla
35. DeCoursey Mountain
36. White Mountain
ANTIMONY
40. Kantishna
41. Fairbanks
42. Stibnite Creek
43. Caamano Point
44. Bennett Lake
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES

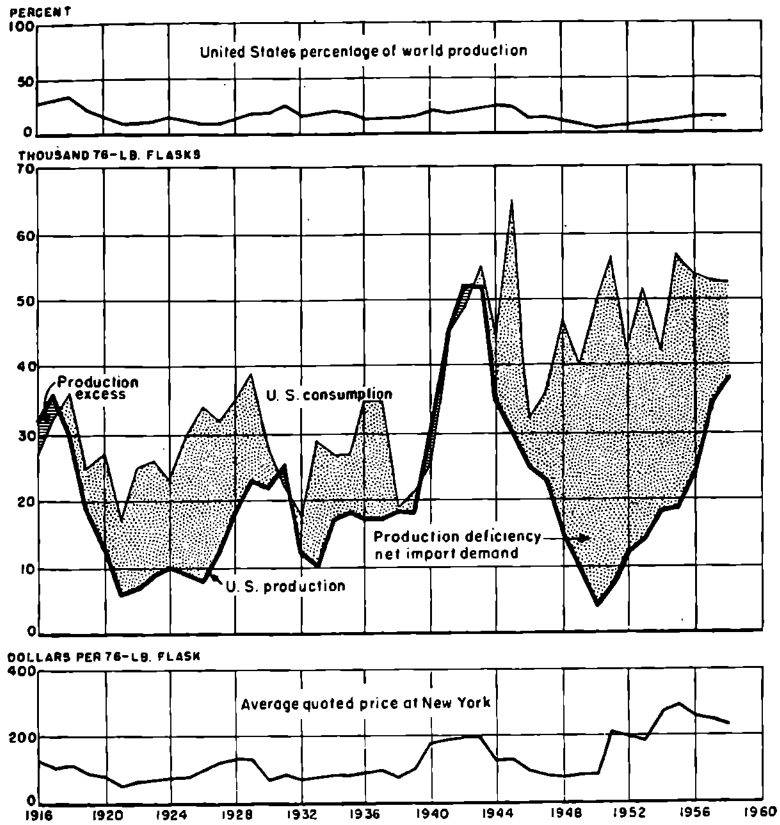

FIGURE V-7. TRENDS IN PRODUCTION, CONSUMPTION, AND PRICE OF MERCURY, 1916-1958

Source: Minerals Yearbook 1958, U. S. Bureau of Mines, Vol 1, p 751.

Major world reserves in Italy, Spain, and the Soviet Bloc, with grade in Spanish reserves running 50 pounds per ton and Italian 16 pounds per ton, much higher than the average 8-pounds-per-ton figure for the U. S. Wide swings in price and resultant domestic production have characterized the industry in the past, and probably will continue in the future. The domestic mining industry has not been successful in its efforts to have the $19-per-flask (25 cents per pound) tariff raised.

Further exploration in the Kuskokwim area in recent years has confirmed widespread mercury mineralization, and it is believed that this region holds considerable promise of developing into a more important producer of mercury in the future. At full scale, the Red Devil could produce 6000 flasks per year. But even at this level, it would still be a relatively small employer of labor for mining and furnacing the product. At its presents rate of 250 flasks per month, 40 men are employed at the operation. It would not appear unreasonable to assume that in the next 20 years the Kuskokwim area might enjoy the development of several mercury operations of the general size of the Red Devil, which, however, would be subject to periodic shutdowns if wide price swings continue to characterize the mercury industry. At best, moreover, these would employ a total of only around 100 persons with a total annual payroll of less than $1 million, and would have relatively minor impact on the Alaskan economy. Even if total output for the region reached 10,000 flasks per year, this would amount to outbound product shipments of only some 500 tons per year, including weight of the flasks.

Construction of a secondary road from Browne to McGrath and thence to Ruby would not only encourage more intensive exploration in this general area, but also might serve to lower costs of transporting supplies into and products out of mercury operations in the Kuskokwim region in the future.

Platinum Metals

The Goodnews Bay Mining Company's dredging operation north of Bristol Bay (Figure V-6, No. 20) has the distinction of being the only producer of primary platinum in the United States. Starting up in 1938, this operation produced an average of around 27,000 ounces annually, worth around $1 million (Table V-1), for about a decade. Operations have been continuous, but quantity and value of output have not been revealed. It is believed that output since 1938 has dropped off gradually to about half this quantity, with value at about the same figure in line with the increased price of platinum. Reserves will last for some 10 years at current operating rate and mining depth to 90 feet (40 feet of stripping and 50 feet of dredging). Additional large reserves are known at depths of 200 feet, but these cannot be reached under present economics.

The operation is close to the coast and obtains all its supplies by boat. Operations are conducted only during the summer months, and all employees are brought in from Washington.

Outlook for additional platinum production in the Area is not promising, though exploration could uncover new commercial occurrences, perhaps as a coproduct of other metal-mining operations. U. S. and world needs will continue to be met mainly from the huge ore reserves known in (1) the Sudbury, Ontario, district and new Thompson nickel mine in Manitoba, Canada; (2) Union of South Africa; and (3) U. S. S. R.

Antimony

Occurrences of antimony, most of which are small, are quite widespread in Alaska, especially in the southwestern part where it generally occurs as a somewhat undesirable ingredient with the mercury ores in the Kuskokwim area, frequently in amounts about equal to the mercury. Other better known occurrences are in the Fairbanks district (Figure V-6, No. 41) which produced a total of about 2500 tons of stibnite (antimony sulfide) in the early part of the century, and the Stampede mine (Figure V-6, No. 40) which has produced some 2600 tons of antimony since 1936. Reserves in the Fairbanks district were estimated in 1947 by the U. S. Geological Survey as 100 to 200 tons of contained antimony, and 1500 to 2000 tons in the Stampede mine. It is also found in rather widely scattered occurrences in Yukon Territory, frequently associated with gold. The most promising area is near Bennett Lake south of Whitehorse (Figure V-6, No. 44).

In spite of this widespread occurrence, however, the future does not look promising for exploitation of limited known deposits or intensified search for new deposits in the Area. Antimony usage, dominated by antimonial lead for storage batteries, bearing alloys, type metal, ceramics, glass, and pigments, has been sliding in the past decade.

Outlook for increased consumption, in spite of recent research efforts, is none too promising except in minor amounts as a semiconductor material in electronics. U. S. consumption has decreased from a 1949-1953 average of about 18,000 tons to some 13,000 tons in 1959.

Abundant reserves in Mexico, Bolivia, and South Africa have been major sources of Free World supply since World War II. Higher cost domestic production simply cannot compete with ores from these sources. The major world reserves are in China, estimated at some 2 million tons of contained metal, which can be produced very cheaply with low-cost labor there. There is always the threat that more Free World countries, including the U. S., might initiate trade with China. As a matter of fact, a sizable shipment of Chinese antimony to Canada was announced in the trade press early in 1960[35] at a price some 20 per cent below prices for delivered European metal.

Nickel

There has been no known commercial production of nickel ores from the Area, though much exploration and development work has been done on the many occurrences known there.

Virtually all the known deposits in Alaska are in Southeastern Alaska, but all of these are of much lower grade than deposits in Canada that are supplying most of the U. S. and world needs.

The more important deposits are as follows:

(1) Bohemia Basin, Yakobi Island, (Figure V-6, No. 10). This deposit has been repeatedly examined since initial major exploration efforts were made during World War II. U. S. Geological Survey estimates reserves at 20 million tons averaging 0.32 per cent of nickel and 0.20 per cent of copper.

(2) Funter Bay (Figure V-6, No. 13). Development work at this deposit permits an estimate of 500,000 tons of material averaging 0.45 per cent of nickel and 0.40 per cent of copper.

Other deposits at Mirror Harbor (Figure V-6, No. 11) and Snipe Bay (Figure V-6, No. 12) are somewhat higher grade but are much smaller.

There remains for brief mention a promising discovery of a copper-nickel deposit beneath Brady Glacier (Figure V-6, No. 14), which was drilled in 1959 and is scheduled for a much more extensive drilling program in 1960. Grade and size indicated by drilling have not been reported, but they must be attractive to warrant the expense of the additional drilling work. Location is close to deep, protected tidewater.

In Yukon Territory, two occurrences are worthy of note: (1) Quill Creek (Figure V-6, No. 16), already briefly described under copper; and (2) Canalask (Figure V-6, No. 15). Quill Creek has a very attractive combined nickel-copper content (2 per cent of nickel and 1.4 per cent of copper), plus substantial values in platinum metals and cobalt, but the delimited size of 737,000 tons is too small for any sizable exploitation. Interest of the Japanese in leasing or purchasing the property has already been mentioned in the "Copper" section. Canalask is a small showing comprising two lenses with an estimated 542,000 tons of material averaging 1.68 per cent of nickel. The present owners report interest by the Japanese in purchasing concentrates from this property, which will be further developed underground in 1960. If this proves favorable, shipment of up to a few thousand tons of concentrates down the Alaska Highway and Haines Cutoff to Haines, and thence by boat to Japan, might be considered likely.

In British Columbia, the only nickel occurrence of note is at Tedideech Lake, east of Juneau (Figure V-6, No. 17). This was discovered in 1956 and has been examined by numerous companies. It consists of a long narrow zone that can be traced for some 35 miles, with nickel reported as quite high grade in spots. Average grade of nickel from the small amount of blasting and trenching done was estimated by observers at 1.5 to 2.0 per cent. One large company that had looked at the deposit was not enthusiastic about its potentials.

Major world reserves of nickel as of 1958 were recently listed by the Bureau of Mines as follows:

	Short Tons of Contained Nickel	Average Grade of Nickel, per cent
Cuba	18,000,000	0.9
New Caledonia	16,000,000	1.1
Canada	4,800,000	1.5
United States	550,000	0.7
Other Free World	14,000,000	Not available

The Canadian and Cuban ore carries cobalt that may run as high as about one-tenth of the nickel content. The huge reserves of International Nickel Company at Sudbury also carry about an equal quantity of copper, plus important values of platinum metals, gold, silver, selenium, and tellurium. The extent and grade of ore reserves of International Nickel Company's new operation (mine, mill, and smelter) at Thompson, Manitoba, have not been announced, but estimates place them as potentially of comparable size with the Sudbury deposit, with grade somewhat lower. They are not included in the Canadian reserves tabulated above.

Examples of size and grade of ore reserves of smaller nickel producers might be cited as follows:

(1) Sherritt Gordon Mines at Lynn Lake, Manitoba. About 14 million tons of ore grading 0.96 per cent of nickel plus 0.54 per cent of copper.

(2) North Rankin Nickel Mines, Ltd., Rankin Inlet, Northwest Territories (northwest coast of Hudson Bay). About 460,000 tons (to 300-foot depth) averaging 3.3 per cent of nickel, 0.81 per cent of copper, 0.03 ounce of platinum and 0.06 ounce of palladium per ton.

(3) Falconbridge Nickel Mines, Ltd., Sudbury district. About 44 million tons averaging 1.45 per cent of nickel and 0.81 per cent of copper. A property being drilled by Falconbridge (Marchant Mining in northwestern Quebec) is reported to have shown nickel values for hole intersections of 1.6 to 24 feet varying from 1.24 per cent up to 4.87 per cent.

(4) Giant Nickel Mines, Ltd., near Hope, British Columbia. About 1.2 million tons averaging 1.4 per cent of nickel and 0.5 per cent of copper.

U. S. consumption of nickel during the decade 1950-1959 has been quite level at a little over 100,000 tons per year, with a peak of 128,000 tons in 1956. The Paley Commission projected U. S. demand in 1975 at 200,000 short tons.

World production has risen from 162,000 tons in 1950 to a high of 314,000 tons in 1957, dropping off a bit in 1958.

Increase in nickel usage in the past decade has undoubtedly been held in check by limitations in supply. Expansions in available supplies (assuming the Cuban picture ultimately will be settled to permit increased output from that important source) will allow U. S. and world consumption to increase at a more rapid rate during the next two decades.

A top official of one of the nickel companies that has done considerable exploration in Northwest North America summed up the Area's potential about as follows: The company believes that anticipated demand for nickel in the next 20 years can probably be met from presently known reserves, but that if they have to seek additional supplies they would not look for them in the area under study. Preferences are definitely in favor of finding ore occurrences of size and grade desired in the ancient Pre-Cambrian rocks of the Canadian Shield.

The immediate prospect for output from the important operations of Freeport Nickel at Moa Bay and of the U. S. Government at Nicaro, in Cuba, is decidedly uncertain. It is difficult to believe, however, that in the long-range future these deposits will not be exploited effectively by someone, with the output contributing importantly to supplying growing, world demand.

The outlook for important nickel production in Northwest North America in the future cannot be considered promising. Small operations may produce modest amounts for export, such as the Canalask and Quill Creek properties in the Yukon. The Brady Glacier deposit could prove to be of major importance. The possibility of developing large nickel operations in the next 20 years is dependent on finding deposits of much larger size and better grade than any now known in the Area, and some of the larger companies interested in nickel have characterized their past exploration results there as quite "disillusioning".

Chromite

Intensified exploration for domestic supplies of strategic minerals during and after World War II and the Korean War, coupled with premium prices paid by the U. S. Government resulted in the development of previously known chromite deposits near the south tip of the Kenai Peninsula (Figure V-8, Nos. 30 and 31). Some 10,000 tons were produced in 1943-1944 and another 22,000 tons in 1954-1957. The latter amount was sold to the U. S. Government at prices that were more than double published quotations for equivalent ore paid by industry.

The deposits are small. Twenhofel[10c] gives U. S. Geological Survey estimates of reserves totaling only around 30,000 tons of ore containing over 40 per cent of Cr_2O_3

and 175,000 tons containing around 20 per cent of Cr_2O_3. Commercial-grade ore for metallurgical use should run over 45 per cent of Cr_2O_3 (long-time standards have been 48 per cent Cr_2O_3 with a Cr:Fe ratio of three to one).

These reserves are insignificant, either in terms of supplying the U. S. needs of between 1 and 2 million tons per year or even comprising the basis for a moderate-sized mining operation. The big major source of world supplies for the future is the huge deposits of the Transvaal in South Africa, where probably well over 100 million tons of ore grading 40 to 45 per cent of Cr_2O_3 occur. Rhodesia, Turkey, the Philippines, and U. S. S. R. are other major sources of large reserves of relatively high-grade ore.

Chromite is found in close association with ultra-basic igneous rocks, and numerous areas in Alaska where these are known may yield discoveries of larger and better chromite deposits from future exploration.

No chromite occurrences of any promise have been reported in the Yukon or northern British Columbia.

Molybdenum

Although molybdenum occurrences are scattered rather widely throughout the Area, prospecting activities have been concentrated on relatively few, and there has been no commercial production reported. Recent years have witnessed more intensified efforts in prospecting.

The deposits that are known to have attracted most interest are briefly described below. Relatively little is known regarding size and grade of most of them.

(1) Shakan, on Kosciusko Island (Figure V-8, No. 1). This is a high-grade but small deposit, estimated at from 10,000 to 20,000 tons of ore averaging 0.9 per cent of molybdenum.

(2) Muir Inlet (Figure V-8, No. 2). This is a fairly large deposit estimated at 8.5 million tons of material averaging about 0.07 per cent of molybdenum. This is much too low grade to be considered commercial, for a long time to come.

(3) Baker Island (Figure V-8, No. 3). This comprises a moderate-size body estimated at several million tons of material averaging less than 0.06 per cent of molybdenum. It is far too low-grade to be considered commercial.

(4) Orange Hill (Figure V-8, No. 4). Small percentages of molybdenum occur in this sizable low-grade copper deposit, roughly around 100 million tons of material that averages around 0.03 per cent of molybdenum. The copper content of around 0.3 to 0.4 per cent is far too low to be considered commercial far into the future.

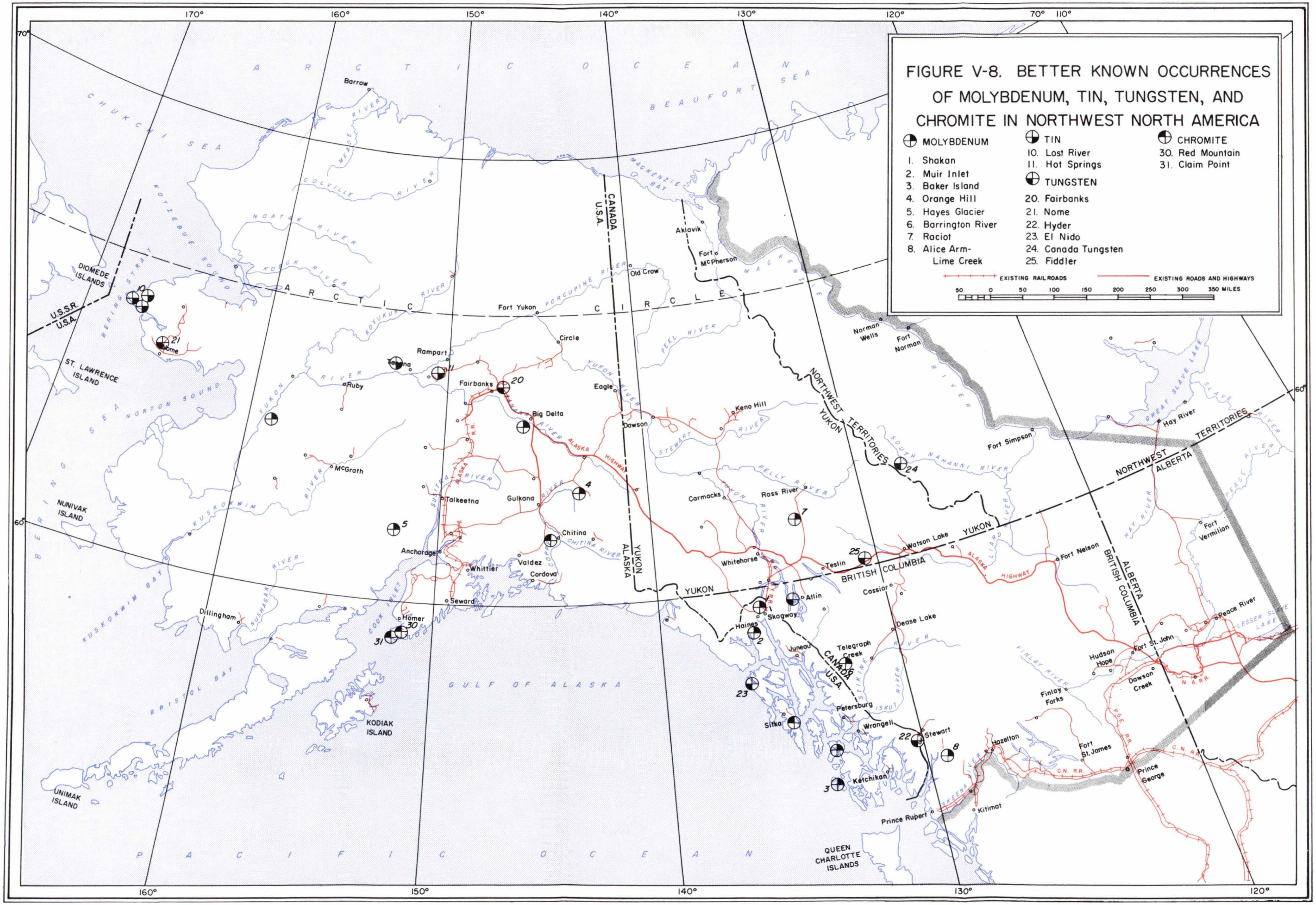

FIGURE V-8. BETTER KNOWN OCCURRENCES OF MOLYBDENUM, TIN, TUNGSTEN, AND CHROMITE IN NORTHWEST NORTH AMERICA

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(5) Hayes Glacier (Figure V-8, No. 5). Virtually nothing is known about this discovery, announced late in 1959, except that it represents a promising showing of substantial size. Major mining companies are interested, and the deposit will be investigated during the 1960 season.

(6) Barrington River (Figure V-8, No. 6). Located near the headwaters of the Barrington River, this is apparently a sizable body of disseminated molybdenite in brecciated and silicified syenite.[36] Some 28 claims have been optioned by American Metal Climax from Conwest Exploration, and considerable stripping and trenching was done in the late 1950's. Nothing could be learned about size and grade of the material.

Many other occurrences of molybdenite have been reported by the Geological Survey of Canada in this same general region.

(7) Raciot (Figure V-8, No. 7). Surface showings in this mineralized granite were very favorable, but work underground in 1959 proved disappointing. More will be done in 1960.

Numerous other molybdenum occurrences in Yukon Territory and British Columbia are shown on a newly published metallogenic map — "Molybdenum in Canada".[37] None of these was indicated as of important significance by authorities on the Area with whom the mineral prospects were discussed.

The U. S. produces about 90 per cent of the world output of molybdenum, estimated for 1959 at just under 30,000 tons, and consumes around 15,000 tons. Consumption in 1975 was projected at 35,000 tons by the Paley Commission, which presently would appear to be on the high side. The future of the metal appears promising, not only in alloy and tool steels but in greases and chemicals, and in high-temperature applications of the pure metal or of molybdenum-base alloys with use of suitable coatings.

Known reserves in the U. S. are huge, however, estimated at about 1.5 million tons of contained metal. About three-fourths of these are in ores averaging around 0.24 per cent of molybdenum, and about one-fourth in copper ores carrying less than 0.12 per cent of molybdenum.

Not included in the U. S. reserve estimate above is an additional amount reported of the same order of magnitude as the total U. S. reserve figure, occurring in the Questa deposit of Molybdenum Corporation of America in northern New Mexico. Extensive geological study and exploration activity under a DMEA contract in the vicinity of this small, steady past producer has proven a huge body comparable in characteristics, size, and grade with the Climax deposit.[33]

In view of the above, the outlook for important molybdenum developments in the Area do not appear promising.

Tin

Of all the strategic minerals, the U. S. is perhaps most deficient in tin, in fact, this is true for all of North America. In spite of intensive exploration for tin deposits in World Wars I and II, none of any real significance has been uncovered in North America. The lode tin deposits of Seward Peninsula, Alaska, probably come the closest.

Tin is also known to occur very sparingly in placers of the Seward Peninsula and Central Alaska, but drilling during World War II indicated it was in such small amounts per cubic yard that it could only be recovered as a by-product in placer gold operations. Later work at Cape Creek on Seward Peninsula indicates the possibility of economic recovery of around 2,000 tons of tin from 1 million cubic yards of gravel in a small placer operation.

Total production in Alaska up to about 1946 amounted to 1,820 tons, mainly from placer deposits on Seward Peninsula since when lode operations in the main have produced an additional 695 tons during the years 1947-1955, as shown in Table V-1.

Greatest interest has centered in the Lost River tin mine (Figure V-8, No. 10) located near the very tip of Seward Peninsula, where occurrence of tin has been known since the early 1900's. Under the stimulus of the Korean War, Government funds were made available to purchase and operate this property from 1951 to 1955 when support was withdrawn and operations ceased.

During this operating period 51,000 short tons of ore averaging 1.13 per cent of tin were treated, from which 687 tons of concentrates averaging 52 per cent of tin were produced. Recovery was only about 61 per cent, and no tungsten, which occurs in small amounts with the tin, was recovered. Operations during this period also indicated that costs (excluding exploration and capital charges but including smelting charges and Seattle office expense) amounted to $1.33 per pound of tin recovered. From comments of knowledgeable mining men, it is possible that better control over dilution of gangue could have at least doubled the percentage of tin in the ore milled, with resulting lower operating costs per pound of tin recovered.

In the late 1940's the U. S. Geological Survey estimated reserves at Lost River at 5500 to 6500 tons of contained tin. Reserves in the Hot Springs District west of Fairbanks were estimated at 1000 to 1500 tons. The Survey felt then that further prospecting in central and southwestern Alaska was warranted.

Major world reserves have been roughly estimated in terms of orders of magnitude by the Bureau of Mines as follows:

	Long Tons of Contained Tin
United States	Negligible
Belgian Congo	500,000
Bolivia	500,000
Indonesia	1,000,000
Malaya	1,500,000
Nigeria	250,000

	Long Tons of Contained Tin
Thailand	800,000
Other Free World	450,000
Soviet Bloc	Not available, but large
	5,000,000

U. S. consumption of primary tin has varied between 50,000 and 60,000 long tons per year for the past decade, except for a high of 71,000 tons in 1950. Great conservational advances have been made in use of tin by the electrolytic plating process, which permits application of coatings of variable thickness on steel plate, or even coating only one side. Difficult supply problems and allocations during past emergencies have sparked this research to cut down on tin usage, and this still continues. Price has exceeded $1.00 per pound by a substantial amount in only 2 years (1951 and 1952), and never has it reached $1.33 per pound, the cost of producing Lost River tin during the period the property was operated.

The above indicates that, from its known tin occurrences, Alaska can count on producing only a modest amount of a few hundred tons per year for perhaps 7 to 8 years, and this only under emergency conditions that might raise the price to a level of around $1.35 per pound that would cover cost. Transportation obviously would be by water from this remote area located so close to tidewater, even though it is open for only a few months out of the year.

Small amounts of tin occur in the placer deposits of the Klondike area in Yukon Territory, and there are geological indications pointing to the possibility of finding lode tin deposits in the highly mineralized Mayo area. Occurrences of any significance are not known in northern British Columbia or other Canadian parts of the Area.

Tungsten

Up to the present, only minor amounts of tungsten have been produced in the Area, as shown in Table V-1. Northern British Columbia produced a total of some 1844 short tons of equivalent 60 per cent WO_3 (tungsten trioxide) concentrates in 1943-1944 and 1952-1954, inclusive, virtually all from the Red Rose mine near Hazelton. Alaska produced a total of only 95 tons of 60 per cent WO_3 concentrates in eight years of intermittent output between 1943 and 1953. These operations were possible only because of the high premium prices paid for the metal by the U. S. Government during most of the period of production. Alaskan output has come from the Hyder district (Figure V-8, No. 22), mainly as a by-product in mining lead, and from the Fairbanks district (Figure V-8, No. 20). The deposits are small; in the late 1940's the U. S. Geological Survey estimated reserves in each district of from 100 to 250 tons of contained WO_3. Tungsten minerals also occur in the tin-bearing veins of the Lost River mine (Figure V-8, No. 10), but the tungsten was not recovered during its operations in the mid-1950's. Reserves there have been estimated at 250 to 400 tons of contained WO_3.

Considerable tungsten is present as the mineral scheelite in many gold placers in the Yukon, Kuskokwim, and Seward Peninsula regions. But since the tungsten value is low compared with that of gold, little effort has ever been made to recover it.

The recently discovered large tungsten deposit just east of the Yukon-Northwest Territories line (Figure V-8, No. 24) of Canada Tungsten Mining Corporation may well prove to be the most important producer of this metal in North America. The discovery has been hailed as a major find, one of two such major "hits" (Cassiar asbestos being the other) in the Area in the past decade or so. Extensive development work there has proved over 1.3 million tons of open-pit ore grading 2.51 per cent of WO_3, with the possibility of substantial extension of these reserves considered very good. Plans were announced in November, 1959, to develop the property through a $5 million program that will include a 300-ton mill scheduled for operation by the fall of 1961. At 250-days-per-year operation and 92 per cent recovery in concentrates, this would amount to a yearly output of about 3.5 million pounds of WO_3 or about 2.8 million pounds of contained tungsten. This would be shipped out as concentrates of about 70 per cent WO_3 content, amounting to around 2500 tons per year. In the form of concentrates this has a value of about $20 per short ton unit (20 pounds) of WO_3 or $1 per pound of WO_3 - about $1300 per ton of concentrates having a yearly value of about $3.2 million.

Most of the equipment and supplies needed to build and equip the mine and mill will be flown in, and the high-value concentrates will probably be flown out to Whitehorse for shipment to Skagway thence south by ocean vessel.

This development has sparked quicker action by the Dominion government in starting construction of the road northward from Watson Lake to Frances Lake, Yukon Territory, thence northwestward and west to Ross River. Canada Tungsten will build a road over easy grades from the mine to a junction with the Watson Lake-Ross River road near Frances Lake.

A small lake near the mine was used for landing heavy Bristol freighter planes during the 1959-1960 winter, and a suitable ground landing strip will be completed in 1960 to permit continuous flying with heavy planes.

Once the plant and road are constructed, an operation of this size (open-pit mine) should employ around 50 to 75 men.

U. S. consumption in the past decade has fluctuated widely between lows of about 5 million pounds of contained tungsten in 1949 and 4 million pounds in 1954, and highs of 11 million pounds in 1951 and 9 million pounds in 1955, 1956, and estimated for 1959. Very high Government premium prices during and following the Korean War sparked U. S. mine production to the point where it was well in excess of consumption during 1953-1956. The excess went into the U. S. Government stockpile, as did much excess production from foreign countries. U. S. production has declined severely and foreign production more moderately since the stockpiling and premium price program ceased.

The planned output from Canada Tungsten will have an important impact on the market. Consumption, however, is expected to rise moderately, aided by growing uses in high-temperature applications. The Paley Commission projected 1975 U. S. consumption at 15 million pounds, which would appear to be somewhat low.

World reserves are estimated, in order of magnitude, at around 2.5 billion pounds of contained tungsten, about 80 per cent of which are in China. The tremendous production potential from this source, at delivered prices below production costs of most U. S. mines, will always stand as a threat to North American tungsten mines in the future. It is not at all unreasonable to assume that trade between the U. S. and Red China will be initiated within the next 5 to 10 years, perhaps sooner.

With the discovery and development of the Canada Tungsten operation with its sizable impact on U. S. markets, it would appear that chances for developing any of the known occurrences in Alaska and British Columbia in the future are very poor. There are possibilities, however, that other discoveries of size and grade comparable with the Canada Tungsten property may be found.

Other Metals

Very brief mention might be made of other metals that have been reported from the Area, but which are not at all promising for future development.

Bismuth occurrences have been reported northeast of Fairbanks, on the Seward Peninsula, east of Ferry on the Alaska Railroad, and northeast of McGrath. Most of the world's bismuth is recovered as a by-product in lead refining, with principal output from Peru, Mexico, Canada, and the U. S. Possible use in semiconductors for thermoelectric uses might boost demand for bismuth substantially in the next 5 to 10 years. It is within the realm of possibility that any sizable lead-bismuth discoveries in the Area could contribute to such a growing bismuth market. Past consumption in the U. S. has been quite stable at around 1.5 million pounds per year.

Uranium occurrences have been relatively few, and the one deposit of any size (Bokan Mountain on the southern part of Prince of Wales Island, Alaska) produced some 17,000 tons of ore running 1 per cent of U_3O_8 before the ore body was depleted. Later exploration has uncovered additional ore, and operations were resumed on a small scale in the summer of 1960. With known U. S. and world supplies and reserves far in excess of anticipated demand, probably at least for 10 to 15 years, chances of finding, developing, and marketing any significant quantities of uranium from the Area up to 1980 are very dim, indeed.

Pegmatites that carry beryllium, lithium, columbium, and tantalum have not been reported in the Area but spectrographic data obtained on numerous samples may support the belief that a beryllium metallogenic province may occur on Seward Peninsula. Much detailed work is required to prove this, however. An experienced Alaskan geologist stated that pegmatites themselves are relatively scarce in Alaska, and those that are found are very lean or lacking in metallics such as those mentioned above.

Industrial Minerals

Some of the industrial minerals, so-called nonmetallics, occur in important amounts in the Area. However, most of the bulky ones that occur in any quantity (sand and gravel, limestone, clays, etc.) are very low-value materials that cannot be shipped very far and can only serve local needs for expanding building or other applications. The one notable exception is asbestos. The latter will be discussed in a little detail, but only brief mention will be made of the others.

Asbestos

Opening of the Alaska Highway, and later the road south from Watson Lake to McDame, stimulated prospecting in northern and northwestern British Columbia and resulted in the discovery and development of the large asbestos deposit at Cassiar (Figure V-9, No. 1). This is high quality, low-iron chrysotile and yields relatively long, soft fibers. It competes for the same markets as those served by the same type of material from Southern Rhodesia.

Cassiar is now producing about 32,000 tons of asbestos per year from the mining and milling of about 350,000 tons of ore (about 9 per cent grade, in terms of products shipped). The 1957 Annual Report of the British Columbia Minister of Mines reported 402,000 tons of ore was milled in 1957 to produce the following grades of fiber[38a]:

	Tons
Spinning Grades	
No. 1 Crude	19.00
AAA	9.60
AA	1,362.10
A	5,786.00
Total, Spinning Grades	7,176.70
Cement Grades	
AC	8,100.95
AK	11,113.95
AS	2,280.45
AX	2,771.20
Total, Cement Grades	24,266.55
Total, All Grades	31,443.25

In the 1958 Annual Report, the same source reported production of 5,824 tons of spinning grades and 25,605 tons of cement grades for a total of 31,429 tons. At an average gross value of $22 per ton of ore milled, the Cassiar output has a total annual value of about $7.7 million, or an average of about $280 per ton of asbestos sold.

Jenkins described the Cassiar grades marketed and 1959 prices fob Vancouver, as follows[39]:

	Price per Short Ton
No. 1 Crude, basically of crude 3/4-in. staple and longer	$1522
AAA - Extra-long textile fiber	787
AA - Long textile fiber	682
A - Textile fiber	494
AC - Long shingle fiber	325
AK - Medium-long shingle fiber	220
AS - Shingle fiber	181
AX - Short shingle fiber	142

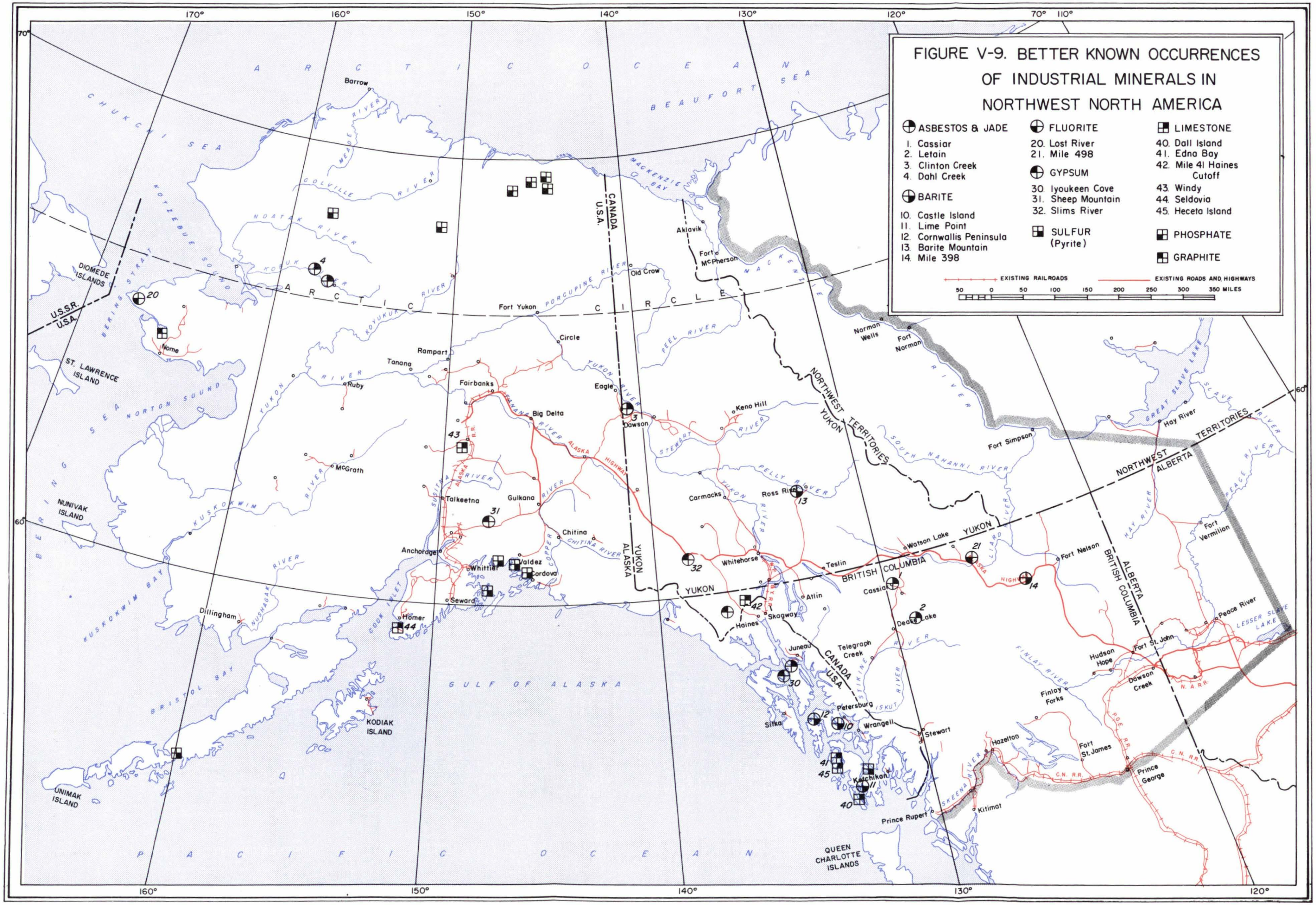

FIGURE V-9. BETTER KNOWN OCCURRENCES OF INDUSTRIAL MINERALS IN NORTHWEST NORTH AMERICA

Expanding sales commitments required a 50 per cent increase in mill capacity from 1000 to 1500 tons per day – scheduled for completion at the end of 1959. Ore reserves are stated to be huge – at least 50 years' supply at the present operating rate. Recent exploration work is reported to have shown improvement in ore grade up to 12 to 13 per cent of recoverable asbestos, and some thought was being given in 1960 to boosting output still further.

The high value of the product permits the long and costly haul. The bagged asbestos is moved by truck from the mill northward to the Alaska Highway, thence westward to Whitehorse, a total distance of 357 miles. It is then transferred to containers and moved by the White Pass & Yukon narrow-gauge railroad 110 miles down to Skagway, where the containers are transferred to the ocean-going vessel of White Pass & Yukon for the trip down the Inside Passage to Vancouver. There it is warehoused and shipped to world markets.

Excellent accounts have been given of the details and economics of this transportation operation[38b, 40] (including, also, the transportation of the United Keno silver-lead-zinc concentrates from Keno Hill to Whitehorse and thence over the same route, but ending mainly at Trail, British Columbia). Costs for the truck haul from Cassiar to Whitehorse average a little over 6 cents per ton mile, or about $22 per ton for the 357-mile haul, with no credit for supplies back-hauled. Transfer of bags into containers at Whitehorse costs about $1.75 per ton. The rate for the combined haul from Whitehorse to Vancouver amounts to $18 per ton, or about 1.8 cents per ton mile. Total cost from Cassiar to Vancouver is thus about $41.75 per ton. Based on gross value of ore mined and milled of $22 per ton, this transportation figures out at about $4 per ton of ore mined and milled, or 33 per cent of the production cost. At a concentrating ratio of a little under 11 to 1, this amounts to a transportation cost for the bagged fiber of something under $44 per ton.

In planning the Stewart-Cassiar road, British Columbia officials estimated substantial savings in the haul to Stewart via the new road would shift the haul of present asbestos output to the new route and permit marketing of shorter fibers (now stocked at the mine) in amounts equal to present shipments. However, conversations with Cassiar officials raise doubts whether either will materialize; the high overload tax recently imposed for trucking on British Columbia highways will amount to more than the savings from the shorter route (310 miles to Stewart versus 357 miles to Whitehorse and a shorter ocean haul). Present specifications for use of Bailey bridges on the highway will not permit use of Cassiar's heavy trucks, but plans call for construction of heavier bridges after completion of the road. In addition, consideration must be given to the possible effect of such a traffic shift on rates and costs of moving the United Keno Hill concentrates; until early 1960 both operations were under the same financial control. Interest of White Pass & Yukon in holding the traffic through rate adjustments must also be taken into account.

Whether the present thinking of Cassiar officials not to ship shorter fibers is based on market or cost considerations (price of shorter-fiber material is much below average prices for grades presently shipped) is not known, but the decision appeared to be firm early in 1960.

Other asbestos deposits are known in the Area, none of which have had considerable exploration and development work performed on them.

Probably the best one, aside from Cassiar, is the Clinton Creek deposit located some 40 miles northwest of Dawson (Figure V-9, No. 3). This is also owned by Cassiar who have done development work indicating reserves there of over 5 million tons of high-grade asbestos ore. The quality of the asbestos is somewhat below that of Cassiar, and the company views this for long-range development when markets and price can justify the longer haul.

Cassiar has also done considerable trenching and underground drilling and cross-cutting on the Caley asbestos property located some 10 miles south of the Clinton Creek deposit, but results were disappointing and the option was dropped in 1959.

The Letain asbestos property is located about 60 miles south and east from Cassiar (Figure V-9, No. 2). It was discovered by Conwest in the late 1950's, and is considered only a fair prospect. No further development work other than assessment activities is contemplated for several years.

Several small occurrences of tremolite and chrysotile asbestos in the Kobuk River region (Figure V-9, No. 4) have been described.(41) Small tonnages of both varieties have been produced, but insufficient development work has been done to appraise their size and potential economic value. Their remoteness, coupled with the plentiful availability of much more easily accessible deposits, will bar their development for more than the 20 years considered in this study.

Future Marketability. Any really meaningful consideration of future demand and supply for asbestos is so complex as to preclude its inclusion here. The material occurs in different mineralogical types, and the uses and prices of the many grades of each type differ so widely as to make market analysis and projections a major project.

The great bulk of asbestos used is the chrysotile type. In 1958 the U. S. consumed some 643,000 tons of chrysotile (compared with 26,000 tons of crocidolite), of which 96 per cent was short fiber of less than spinning length and was used mainly by the construction industry – much of it in asbestos-cement pipe and other forms for which use is growing rapidly.

The amounts of high-quality, low-iron, long-fiber crude asbestos produced in the Area are used largely for its superior electrical resistance in electric cable coverings and primary electrical insulation on magnet wire; other uses are for fire-fighting suits and ironing boards. It is also used as spinning fiber in making the asbestos fabrics that find usage in a great variety of applications.

As cited above, however, the major tonnage produced at Cassiar comprises Grade A textile fiber and Grades AC and AK long and medium-long shingle fiber. The textile fiber is used for a variety of purposes, probably mainly for textiles (in which the low iron would permit its use in electrical insulation), but also in long-fiber asbestos papers, packings, gaskets, pipe coverings, heavy-duty brake linings, and insulation blocks. The shingle fiber may be used in asbestos-cement products, papers, pipe coverings, packings, gaskets, etc., in addition to its common use for shingles.

The future growth in demand for the premium-quality material from Cassiar, whether in spinning or "cement" grades, would appear to be assured. Growth in demand for asbestos in cement has been strong recently, and a doubling of this use in the next

20 years should be a reasonable projection. A new use for the short fibers (so-called "shorts" or "refuse") that appears to have a sizable market potential is as a bonding material for asphalt in paving, where it reportedly produces a tougher, safer road surface.

Supplies of low-iron, long-fiber chrysotile are none too plentiful; growing needs resulted in increasing milling capacity at Cassiar by 50 per cent, effective at the beginning of 1960. Supplies of regular-grade chrysotile, both long and short fiber, were greatly increased by expansions in mine and mill capacity in eastern Canada and by the addition of a large new producer during the past few years. In total, the industry has a substantial overcapacity for production at present, and research efforts are being pressed to find large new uses for the material.

All in all, it would appear plausible to visualize the need for developing Clinton Creek to a producer comparable in size to Cassiar within a period of 8 to 10 years. This might then employ roughly 500 people in that operation and produce some 40,000 tons per year to be transported southward.

Sulfur

With the completion late in 1957 of the 650-mile 30-inch natural gas line south from the Peace River gas field near Fort St. John, many of the previously drilled gas wells started production. At the same time, production of sulfur was started in a 425-ton-per-day recovery unit in which the high H_2S content of the natural gas is separated and converted to elemental sulfur. This separation is necessary prior to transmission of the gas. Output in 1958 totaled 62,600 short tons, and in 1959 it was 53,700 tons. This has been a boon to the Pacific Great Eastern Railroad; all of it moves south to Prince George, and thence much moves west on the Canadian National Railroad to a number of pulp and paper mills in the area, to be used in their manufacturing operations, and most of the remainder moves south to the Vancouver area. Difficulties in marketing the total output were being experienced in 1960, and stocks at Fort St. John were building up.

The huge gas discoveries in northeastern British Columbia are sweet gas, so its exploitation and transmission will not result in augmented supplies of sulfur from that area.

Whether it be considered fortunate (no need of separating it) or unfortunate (lack of cheap raw material for pulp mills, fertilizers, and other chemical use), the gas found in the Kenai area of Alaska is sweet and dry – almost 100 per cent methane. This is likewise true of gas found at Gubik.

Alaska's sulfur resources are pretty much confined to the deposits of iron sulfides that are rather abundant in the area around Prince William Sound and in parts of Southeastern Alaska. Its value will be pretty much limited to supplying local needs for sulfur and sulfuric acid, once chemical industries develop in the area.

Sulfur is also known to occur associated with recent volcanoes out on the Aleutian Islands. Deposits on Makuskin Volcano have been estimated by the U. S. Geological Survey to contain 33,000 tons of sulfur, 9,000 tons in material estimated at 60 per cent of sulfur, and 24,000 tons in material containing around 23 per cent of sulfur. More may be found in these little-explored areas.

With respect to marketing the apparent excess supplies from British Columbia, a mining official in Toronto reported that by-product sulfur from Alberta is now being marketed in eastern Canada by the granting of extra low freight rates by the railroads. Its separation from the gas is mandatory so the producers can sell at almost any price that will permit it to compete with sulfur from other sources in large eastern markets. British Columbia sulfur might find such outlets for excess supplies in the East.

Limestone

Limestone deposits of large size and high purity are found on many of the islands in Southeastern Alaska.[42] Shown on Figure V-9 are only three of the 24 deposits (No. 40, Dall Island; No. 41, Edna Bay; and No. 45 Heceta Island) described excellently in the pamphlet in terms of location, size, quality, geologic relations, economic uses, accessibility to dock and harbor facilities, available fuel, etc. Hundreds of millions of tons are available covering rock meeting specifications for a variety of uses — rock for cement and lime manufacture, chemical use, flux stone, calcium carbide manufacture, agricultural lime, etc. One property on Dall Island operated quite steadily on a 6-month-per-year basis from 1928 to 1940, and again in 1948 and 1949. Opening up of limestone deposits in Washington coupled with legal difficulties in Alaska displaced this source for raw materials for cement manufacture in the Pacific Northwest, but 1960 activity of a large cement company in constructing a barge camp for limestone development work on Dall Island apparently presages planned resumption of limestone quarrying for shipment south to its plant in Washington.

Extensive studies have been made of limestones accessible to the Rail belt in Alaska[43] as potential raw materials for portland cement manufacture for construction needs in that area. The Windy deposit (Figure V-9, No. 43) has probably had the most work done on it, but it is found to be of erratic and often too high magnesia content to serve for this purpose. The Bureau of Mines concludes that the best limestone for portland cement is found at Foggy Pass, lying some 8 miles west of the Windy property, where a deposit of sufficient size and satisfactory quality was found.

The limestone deposit near Seldovia (Figure V-9, No. 44) is too high in magnesia for good cement stone, although plans were made shortly after World War II to make cement from this deposit by using coal from deposits near Homer. Inability to raise necessary capital for plant construction blocked further action.

Announcement was made in the summer of 1960 by Kaiser Permanente Cement Co. of plans to construct a 500,000-barrel-per-year cement plant near Anchorage. At capacity operation this would require a small quarrying operation of only something over 100,000 tons per year of limestone.

A large deposit of high-purity limestone at Mile 41 on the Haines Cutoff (Figure V-9, No. 42) was reported by Twenhofel.[10d] This could serve as high-quality chemical stone, as stone for cement manufacture, flux for steel or other metallurgical use, or calcium carbide manufacture.

Limestones occur interbedded with other sedimentary rocks of the Paleozoic series in the Yukon and parts of British Columbia, but are considered of no importance to this study.

Clay and Shale

Clay and shale deposits in the Area have potential use mainly as a source of raw material for making structural clay products for use in the Area. With population centered at both ends of the Rail belt of Alaska, major interest has been focused on deposits in that region. There are no deposits of such high purity of kaolin or other special types as to be considered for potential export.

The picture for clay and shale for ceramic use in the Rail belt might best be described briefly by quoting the summary of the extensive sampling and testing program conducted by the U. S. Bureau of Mines in the early 1950's[43a]:

"Nine deposits or formations within the Railroad belt were investigated as sources of raw material for brick and tile products. As a result of the incomplete Bureau of Mines program, the following conclusions can be made:

"The Anchorage area has clay that is satisfactory for the production of brick. Although this glacial clay, as represented by the samples from Clay Products, Inc., has a short firing range, closely controlled firing will produce brick that will withstand the rigorous climate of the area.

"A sample from the Chickaloon formation near the road to the Evan Jones coal mine gave indications of a possible source of shale for structural-clay products. Additional sampling to locate a supply of material of this type is in order. Such a deposit should be readily accessible to the Anchorage area.

"Clay from the Alaska Gypsum Queen Corp. claims on Sheep Mountain gave the best results of all the samples tested for ceramic uses. The clay has excellent working characteristics and fired strength.... Excellent resistance of the product to weathering is indicated by lengthy freezing and thawing tests. The Sheep Mountain clay, with proper preparation, such as washing, is capable of producing a brick of high heat duty for refractory use.

"Next to the clay from Sheep Mountain, the shales from two of the most prominent shale members of the Healy coal formation show the best possibilities for the production of brick of all the deposits sampled. The results of freezing and thawing tests indicate that a product can be made that will withstand the rigorous climate of the Railroad belt."

Lightweight Aggregate

This material, again, is of major interest as a construction material for local use in the relatively populous areas along the Rail belt. The U. S. Bureau of Mines summarized the occurrences as follows:[43b]

"Shales and other argillaceous rocks amenable to the production of the lightweight aggregate Haydite occur in several localities within the Railroad belt. One of the best of those tested is at mile 67 (near Sutton) on the Glenn Highway, where it is readily accessible to the Matanuska Valley and to the Anchorage area. Preliminary tests indicate that the lightweight aggregate produced has a fine, vesicular structure, with uniformly spaced pores.

"A shale from mile 16 on the Matanuska branch of the Alaska Railroad is of similar age and composition to the mile 67 shale; it gave similar results in preliminary bloating tests.

"Of the other formations tested for their bloating characteristics and possible use as lightweight aggregate, two samples of argillite near Indian River 4 miles south of Chulitna Station gave the best results.

"One deposit that was not directly within the Railroad belt was sampled. This was a blue clay bed near Miller's Landing at Homes, Alaska. Preliminary tests indicate that the clay bloats at a comparatively low temperature, below 1100°C, and gives an excellent volume increase. There was some indication that this material may bloat before the outer surface reaches a pyroplastic condition, permitting the production of aggregate in a gradation of sizes that does not require crushing after processing.

"Pumice, a natural lightweight aggregate, occurs within the Katmai National Monument on the Alaska Peninsula and also on Augustine Island in Cook Inlet. Although no samples have been taken by the Bureau of Mines, building units of excellent strength and appearance have been produced from this material.

"One occurrence of perlite in the Healy area was investigated during 1950 by the Geological Survey. Two specimens procured from the Geological Survey by the Bureau of Mines compare favorably with Arizona and New Mexico perlites, which are being processed for plaster and concrete aggregates."

The U. S. Geological Survey has recently completed a supplementary study of bloatable clays and shales in the Rail belt.[44] Several deposits of satisfactory material for making lightweight aggregate are described in detail, including the deposit at Mile 67 on the Glenn Highway (Sutton) described above. Reserves at Kings River are estimated at 35 million tons and those at Sutton at about 25 million tons. The material is considered satisfactory for making lightweight aggregate, and is located close to coal supplies in the Matanuska Valley for fueling the bloating operation.

Gypsum

Gypsum is another comparatively low-value bulk commodity that finds major uses in making prefabricated building products such as lath and wallboard, plasters, and as a retarder in portland cement.

Deposits are scarce in the Area. The deposit on Iyoukeen Cove of Chichagof Island (Figure V-9, No. 30) was mined for a short time and the product shipped to the Puget Sound area. Beds are about 7 feet thick, containing two 1-foot-thick beds of limestone. Whether seawater seepage, markets, or economics of mining such a thin deposit with interbedded limestone caused abandonment of the operation is not known.

A small deposit on Sheep Mountain along the Glenn Highway (Figure V-9, No. 31) was sampled and mapped by the U. S. Bureau of Mines and Geological Survey, and produced small tonnages for an Anchorage wallboard manufacturer around 1950. It is not satisfactory for use as a retarder for portland cement manufacture.

Beds of gypsum are reported to outcrop along the northwest side of Slims River near the Alaska Highway in Yukon Territory (Figure V-9, No. 32).

U. S. markets on the West Coast are amply supplied from California's 12 mines (in 1958) and one in Washington. Reserves there are ample for many decades.

Phosphate Rock

The only deposits of phosphate rock known in the Area were discovered on the Arctic Slope of Alaska during the geologic investigation of Naval Petroleum Reserve No. 4 between 1944 and 1953 (Figure V-9). Conclusions of this study are quoted as follows[45]:

> "The phosphate deposits in the black chert and shale member of the Alapah limestone (Mississippian) have been measured and sampled at two localities in the central Brooks Range and Arctic foothills provinces. Nearly all the phosphate rock (25 per cent or more P_2O_5) was found in thicknesses of as much as 37 inches, but no thicknesses of acid-grade phosphate rock (31 per cent or more P_2O_5) exceed 16 inches. A comparison of measured sections of the black chert and shale member in the upper Kirukatagiak River, Tiglukpuk Creek, and Shainin Lake areas indicates that there are marked lateral variations in lithologic character as well as phosphate content. Because of these facies changes and because of the complex structure of the rocks along the mountain front, further work will be necessary before the black chert and shale phosphate deposits can be fully evaluated.
>
> "Samples of phosphate rock containing as much as 35.8 per cent P_2O_5 have been found in the Shublik formation (Triassic) in the eastern Brooks Range. Nothing is known about the thickness and extent of the deposits, but, because of the grade and widespread distribution of the samples, further investigation would seem warranted."

Phosphate rock is a low-value product that requires cheap water transportation for movement over any distance. U. S. reserves are of the order of 1000 times present annual production, distributed mainly in southeastern and northwestern states. Supplies are also plentiful in Oceania (Nauru Island) and Australasia.

Even if the deposits in Alaska were much richer, their isolated location along the Arctic Slope with access only to the Arctic Ocean would preclude their development – certainly in the 20-year future covered in this study.

Fluorspar

Probably the most important fluorite deposit in the Area is located at Mile 498 on the Alaska Highway in northern British Columbia (Figure V-9, No. 21). This occurs in a general zone where hot springs are presently depositing fluorine and barium-containing minerals. The deposit is up to 20 feet thick, grading 25 to 35 per cent of fluorite with some witherite (barium carbonate).[46] Lengthy and costly transportation to markets will prevent development of this for a long time.

The only other deposit of any size is in the Lost River tin mine on Seward Peninsula (Figure V-9, No. 20), where it occurs both as irregular veins and replacement bodies quite separate from the main tin-bearing dike, and (most important) as fluoritized limestone zones bordering the main tin-bearing dike. The Geological Survey estimated reserves of between 300,000 and 400,000 tons of fluorspar in this entire deposit. Grade is not nearly high enough to consider mining for the fluorspar content in this remote, high-cost area.

Small scattered deposits are also known in the Wrangell district of Southeastern Alaska, but nothing approaching size and grade for commercial exploitation.

Barite

Occurrences of barite are known in Southeastern Alaska on Castle Island, Lime Point, and Cornwallis Peninsula (Figure V-9, Nos. 10, 11, and 12, respectively). The Castle Island and Lime Point deposits are both replacement deposits of limestone; reserves at Castle Rock are estimated at 50,000 tons of barite above high tide, and at Lime Point about 5000 tons above low tide. Possibility of increasing the reserves is considered dependent on discovery of additional deposits rather than on extensions of the presently known deposits.

Location of the barite on Castle Island and Lime Point directly on tidewater might warrant another look at these deposits as possible sources of barite for oil-well-drilling muds if the active drilling program in Alaska develops really major fields.

A deposit of barite occurs along the Alaska Highway in northern British Columbia in the hot spring zone previously mentioned under "Fluorspar", only about 50 miles west of Fort Nelson.(46) Location reasonably close to the oil-drilling activity in northeastern British Columbia, in which it may be used for oil-drilling muds, could appear to justify more thorough investigation of this deposit than it has received in the past.

Large deposits of highly pure barite occur on Barite Mountain about two miles west of Mile 118 on the Canol Road (Figure V-9, No. 13). Kindle(47) estimated reserves as 50,000 tons of proved barite, with much additional as prospective. Samples tested showed $BaSO_4$ content of 99.2 and 99.7 per cent. Remoteness of the deposit and relatively low value of the material ($18 per ton) will preclude exploitation of this deposit for a long time.

Graphite

Occurrences of graphite are known on Seward Peninsula (Figure V-9, No. 50), where 50 tons of measured reserves were reported(48) in the form of sorted material that had been stockpiled and 65,000 tons of rock containing 52 per cent of graphite. Whether the sorted material would meet specifications for strategic crystalline flake graphite is not reported. The amorphous material occurs in great abundance in the United States, and stands no chance of exploitation from this remote area.

Jade

Both nephrite and jadeite have been found as pebbles and boulders and in a lode deposit associated with asbestos in the Kobuk region of northwest Alaska (Figure V-9, No. 4). Shipments of this high-quality gem-stone material have been sent out of the district. Much of it is carved into various types of jewelry (in Germany), and some of this finds its way back to Alaskan gift shops. Lesser amounts are used by Eskimos in making simple jade carvings. Tonnages of material involved in this small-crafts industry are negligible.

Sand and Gravel

Sand and gravel occur quite abundantly throughout the Area, but in some large areas, especially those that have not been glaciated, problems are encountered in finding sufficient material close at hand for building purposes, road metal, and other uses. In some of the extensive flat areas, sand and gravel, if present, may be deeply buried by fine silt or soil, may occur below ground-water level, or may be perpetually frozen. Difficulties in locating the material are encountered along sizable stretches of the Alaska Railroad, for example.

Nevertheless, sand and gravel fortunately are abundant near populous areas, and production in the past decade jumped as a result of the extensive Government construction program. As shown in Table V-1, output jumped from minor quantities to over 3 million tons in 1950 and reached a peak of over 10 million tons in 1952, since when it has fluctuated around 5 to 7 million tons except for another high of almost 10 million tons in 1955. Its value is only a little under $1 per ton, but in total it almost equals that of gold from the state.

Its use is of interest to this study in connection with its availability for road construction rather than as a resource requiring improved transportation for its exploitation.

Summary

The foregoing discussion indicates in a broad, general way that known metal and mineral deposits in the Area are either too low grade if they are large enough or are too small if grade is sufficiently high to allow for commercial development under present market conditions. By and large, the latter should not change materially in the next 20 years. High costs for labor, equipment, and supplies in the Area, especially Alaska, are a serious obstacle to mineral development.

The one outstanding assured new operation is that of Canada Tungsten Mining Corporation in Northwest Territories north of Watson Lake, which will produce some 2500 tons of tungsten concentrates per year starting in 1961. Operations for a number of years, at least, will be by open-pit mining.

Beyond this, best short-term prospects for commercial operation are the iron deposits of Southeastern Alaska – both the medium-grade ore in relatively small deposits and the large low-grade ore deposits requiring concentration, with main market potentials in Japan. All of these would be open-pit operations. If large blocks of electric power could be made available at around 4 mills per kwhr it is plausible to think in terms of a substantial pretreatment — electric smelting operation producing say 1 million tons of steel per year at Klukwan, for marketing on the U. S. West Coast in the next 5 to 10 years. Smaller blocks of low-cost electric power might be utilized to smelt iron-ore concentrates at Snettisham to produce say 175,000 tons of pig iron annually.

Mercury prospects in the Kuskokwim River area might well develop into several new mercury producers within 20 years, producing say 12,000 flasks annually worth about $2.5 million. Output could be flown out as from the Red Devil at present, but trucking over a new access road would be much cheaper.

It is likewise plausible to visualize development of the Vangorda Creek lead-zinc-copper deposit in Yukon Territory by open-pit mining in the next 5 years, producing around 70,000 tons of concentrates per year for shipment through Whitehorse and Skagway to Vancouver and Trail, British Columbia. The Hyland River zinc-lead-silver deposit might be opened up at a lower operating rate. A road up the Taku River might tip the economics in favor of reopening the Tulsequah mine with an annual output of some 30,000 tons of zinc concentrates and byproducts.

Within perhaps 8 to 10 years the Clinton Creek asbestos property north of Dawson might well be developed as an open-pit operation, with an annual output of 30,000 tons of asbestos fiber, shipped to Whitehorse, Skagway, and Vancouver.

Four low-grade copper deposits — Sumdum, Kobuk, Scud River A, and Scud River B — might be exploited starting some 10 to 15 years hence, each producing at an assumed rate of 10,000 tons of ore milled per day or say 108,000 tons of concentrates per year. A higher grade to make ore at Kobuk would raise the annual output to around 160,000 tons of concentrates. Finally, the Granduc copper property might well be developed in 5 to 10 years, with an assumed output of around 10,000 tons of ore daily, or around 195,000 tons of concentrates per year. These would be moved to the coast for shipment probably to the Tacoma copper smelter.

A limestone deposit near Sutton in the Rail belt will be used for cement manufacture, and extensive deposits on Dall Island or nearby in Southeastern Alaska might well be exploited at around 1.5 million tons per year for shipment to Washington or Oregon for cement manufacture.

Table V-4 summarizes this picture of the most plausible new metal and mineral developments in the Area during the next 5 to 20 years based on presently known deposits.

Except for Kobuk, Kuskokwim mercury, Vangorda Creek, Canada Tungsten, and Clinton Creek, all the deposits are on or reasonably close to tidewater. New roads would be needed by all of these plus the Scud River deposits – the latter to provide year-round access to deep tidewater.

In addition, smaller operations might be developed in Yukon Territory at Quill Creek and Canalask, and future development might indicate substantial producers at Johobo in Yukon Territory and at Brady Glacier in Southeastern Alaska.

All of those listed, however – with the exception of Canada Tungsten – are highly conjectural, and will depend on the nature of competitive discoveries and developments elsewhere in the world and on assumed growing markets. It is quite possible that none of them will be developed within the 20-year period covered by the study.

TABLE V-4. MOST PLAUSIBLE NEW METAL AND MINERAL DEVELOPMENTS IN NORTHWEST NORTH AMERICA DURING NEXT 5 TO 20 YEARS, BASED ON PRESENTLY KNOWN DEPOSITS

Deposit	Metal or Mineral	Estimated Size, tons of ore	Estimated Grade, per cent	Estimated Annual Output		Estimated Population Increase			
				Short Tons	Value, dollars	Employees	Dependents	Secondary Business Incl. Dependents	Total
Klukwan (fan)	Iron	500 million	12	2 million conc.	16,000,000	700	1400	2100	4200
				1,050,000 steel	73,500,000	1500	3000	4500	9000
Snettisham	Iron	400 million	17	325,000 conc.	2,780,000	190	380	570	1140
				175,000 pig iron	8,750,000	365	730	1095	2190
Kasaan area (6 deposits)	Iron	25 million	40-50	600,000 ore or conc.	4,280,000	65	130	195	390
Hines Creek	Iron	500 million	33	350,000 steel	25,000,000	500	1000	1500	3000
Sumdum	Copper	30 million[a]	1[a]	108,000 conc.	16,000,000	450	900	1350	2700
Kobuk	Copper	100 million	1.5[b]	162,000 conc.[c]	24,000,000	450	900	1350	2700
Scud River A	Copper	50 million[a]	1[a]	108,000 conc.	16,000,000	450	900	1350	2700
Scud River B	Copper	50 million[a]	1[a]	108,000 conc.	16,000,000	450	900	1350	2700
Granduc	Copper	30 million	1.8	195,000 conc.	29,000,000	700	1400	2100	4200
Vangorda Creek	Lead-zinc-copper	10 million	4.84 zinc 3.05 lead 0.3 copper 1.8 oz silver/ton	70,000 conc.	8,000,000	300	600	900	1800
Quill Creek	Nickel-copper	730,000	2.0 nickel, 1.4 copper	4,000 conc.	2,000,000	25	50	75	150
Canalask	Nickel	540,000	1.7	4,000 conc.	1,000,000	25	50	75	150
Kuskokwim area	Mercury	?	2	500 mercury	2,500,000	100	200	300	600
Tulsequah	Zinc + others	?	8 Zn, 5 oz silver	30,000 conc.	5,000,000	100	200	300	600
Canada Tungsten	Tungsten	1,300,000	2.5 WO_3	2,500 conc.	3,200,000	150	300	450	900
Dall Island	Limestone	300 million	High quality	1,500,000	1,500,000	100	200	300	600
Clinton Creek	Asbestos	5,000,000	10	30,000 asbestos	8,000,000	400	800	1200	2400

(a) Highly conjectural.

(b) Grade probably required to make operation economic, which is higher than that shown by drilling through 1959 season.

(c) Might be around 50,000 tons of blister copper smelted near the mine.

Thus, any assured metal or mineral developments of major size in the Area are quite completely dependent on finding deposits that are bigger and/or higher grade than those now known. Although some large mining companies that have been actively exploring the Area in the recent past are disappointed with the results and speak of their experiences as "disillusioning", others are quite optimistic and consider the Area good "hunting ground" for metal discoveries. There is still the strong hope of making one or more new fabulous finds comparable with the United Keno and Kennecott deposits.

But in this metal "hunting" game, again, the Area must compete for exploration dollars with other areas throughout the world, and, to be realistic, the Area has its drawbacks. Mountainous terrain, short seasons, fickle weather, scarcity of lakes for landing airplanes, and remoteness combine to make prospecting in much of the region more costly by far than in many other geologically attractive areas, such as the Precambrian Shield of northern Canada.

Nevertheless, exploration activities are being pushed by mining companies, and the Alaska Department of Natural Resources estimates annual prospecting and exploration expenditures in Alaska during the past 4 years at between $1 million and $1.3 million, exclusive of oil and gas. Recent social and political developments in many foreign areas have augmented the risk factor in developing and conducting enterprises abroad. Continuation of this trend might well cause mining companies to expand their exploration efforts in Northwest North America, where the "business climate" is more attractive and relatively secure.

Since future mineral development depends so heavily on exploration efforts, a map was prepared of the entire Area showing comparative lode-metal potential, Figure V-10. Areas are shown in classes of promise for lode-metal discovery and production from the most promising (moderately high potential) to least promising (nil). This means of portrayal was taken from an unpublished map prepared by the British Columbia Department of Mines, and was extended up through Yukon Territory and Alaska. In developing this map for these latter areas, reports by Bostock(2) and Aho(49) were very useful for Yukon Territory, and numerous maps on physiography, geology, and metal occurrences were of major help for Alaska. It should be emphasized that the classification of areas is based only on general knowledge and judgment and serves only as a broad indication of the relative promise of finding metals in the various areas. It has been critically reviewed by government and industry geologists well acquainted with most of the areas; their help in making suggestions for modification is gratefully acknowledged.

The map serves a useful purpose as a guide in pointing out more favorable locations for roads that may well serve as an incentive to more intensive prospecting and exploration through easier and cheaper accessibility for the search, and providing assurance of a means of moving equipment and supplies in and products out if discoveries are made.

More intensive effort by government geological surveys in completing the semi-detailed and systematic quadrangle mapping of the region at a scale of about one mile to the inch might in itself turn up important mineral discoveries and would be of great assistance in attracting and guiding more intensified exploration by industry. It has been estimated that, with respect to Alaska, about 50 per cent of the area has been covered by geologic mapping at scales of four or two miles to the inch, but that detailed geologic

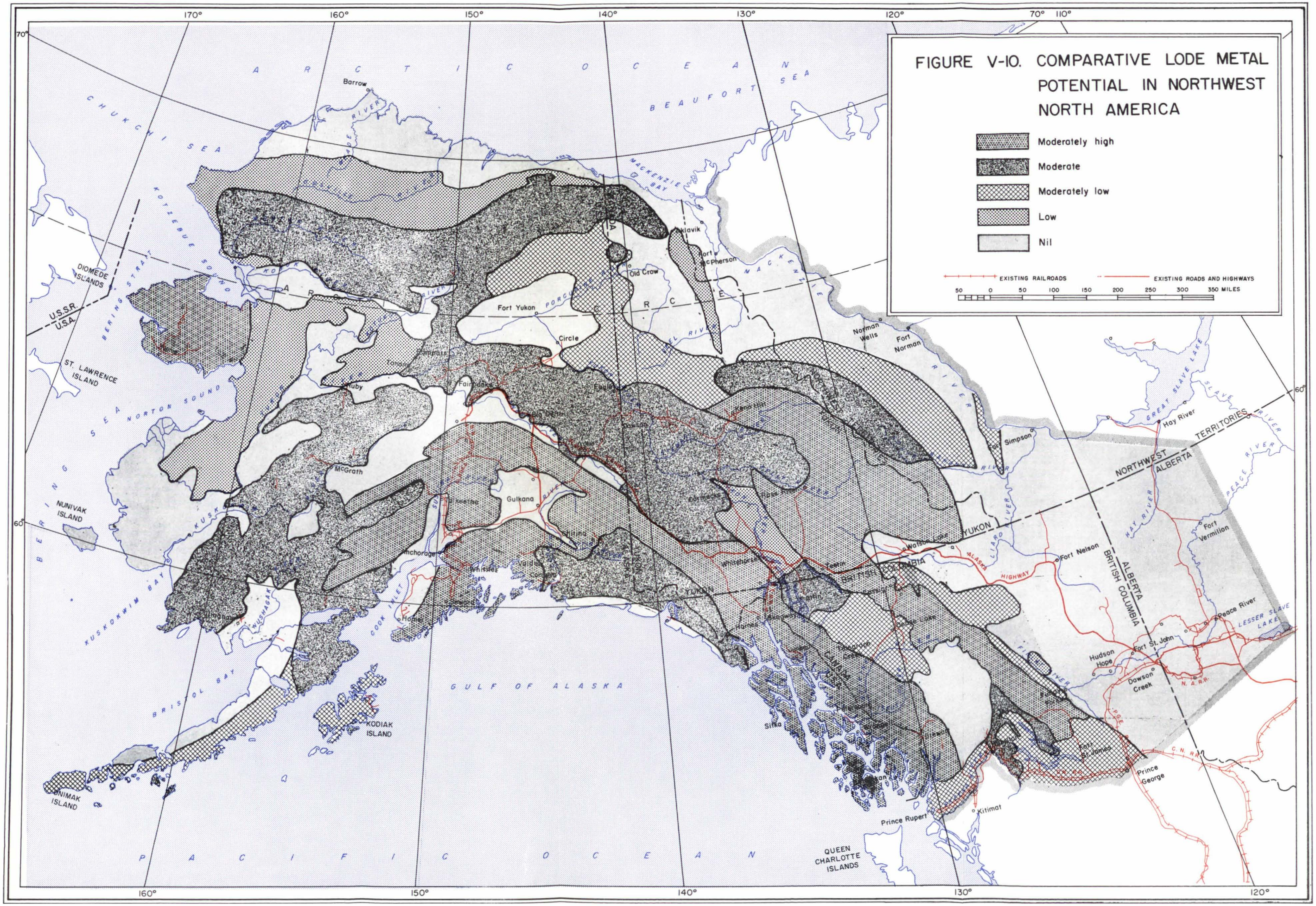
FIGURE V-10. COMPARATIVE LODE METAL POTENTIAL IN NORTHWEST NORTH AMERICA
Moderately high
Moderate
Moderately low
Low
Nil
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
KOTZEBUE SOUND
BERING STRAIT
DIOMEDE ISLANDS
U.S.S.R.
U.S.A.
ST. LAWRENCE ISLAND
NORTON SOUND
BERING SEA
NUNIVAK ISLAND
KUSKOKWIM BAY
BRISTOL BAY
UNIMAK ISLAND
KODIAK ISLAND
GULF OF ALASKA
COOK INLET
PACIFIC OCEAN
QUEEN CHARLOTTE ISLANDS
MACKENZIE BAY
MACKENZIE RIVER
PORCUPINE RIVER
PEEL RIVER
SLAVE RIVER
PEACE RIVER
HAY RIVER
GREAT SLAVE LAKE
LESSER SLAVE LAKE
Barrow
Aklavik
Fort McPherson
Old Crow
Fort Yukon
Circle
Ruby
Tanana
McGrath
Gulkana
Anchorage
Whittier
Homer
Sitka
Prince Rupert
Kitimat
Norman Wells
Fort Norman
Fort Simpson
Hay River
Fort Vermilion
Fort Nelson
Watson Lake
Peace River
Hudson Hope
Fort St. John
Dawson Creek
Fort St. James
Prince George
ALASKA HIGHWAY
NORTHWEST TERRITORIES
ALBERTA
BRITISH COLUMBIA
YUKON
N.A.R.R.
C.N.R.
P.G.E.
170°
160°
150°
140°
130°
120°
110°
70°
60°

mapping at one mile to the inch, of major use to companies in exploration activities, has covered only about 3 per cent of the state. More intensive detailed geologic mapping in Alaska by the U. S. Geological Survey is urgently needed and is fully warranted.

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COAL

Coal is widely distributed throughout Alaska and that portion of northwestern Canada of concern to this study. Coal of all ranks is represented, although the largest deposits are of subbituminous and lignitic rank occurring in the more lightly deformed rocks. Much of the coal, however, is located in remote and relatively inaccessible areas, and only a few fields close to lines of transportation have been developed.

Past Production

Alaska

Until World War I, only a few thousand tons were mined annually in Alaska on a commercial basis, and the fuel needs of the Territory were supplied largely by imports, chiefly from Washington and British Columbia. The first important impetus to coal mining began in 1916, when construction of the Government-owned Alaska Railroad from Seward was started. The coal fields in the Nenana and Matanuska areas were opened up and the railroad itself became the principal consumer of Alaskan coal. In subsequent years, until World War II, the demand for coal in Alaska remained in the range of from 130,000 to 200,000 tons annually, and the proportion supplied by locally mined coal rose from about 32 per cent in 1917 to 90 per cent in 1940. Since World War II, the tonnage of imported coal has been negligible.

Table V-5 shows the production of coal in Alaska during the 20-year period from 1939 through 1959, together with the number of mines and the tonnages produced in stripping and underground operations. Of interest here is the increase in coal production since the beginning of World War II, particularly the sharply increased tonnages mined in 1952 and subsequent years. By far the largest part of this is accounted for by the increased fuel requirements of large military installations in the Anchorage and Fairbanks areas.

Until 1946, commercial production was entirely from underground mines. Two stripping operations then began operations. Since 1952 production from stripping operations has exceeded underground production, and in 1958, 73 per cent of the total tonnage was produced in that manner.

During 1959, active commercial coal mines in Alaska were as follows:

Nenana Field (subbituminous):

Arctic Coal Company, strip, average crew 11; operated during last half of 1959 after receiving a military contract.

Cripple Creek Coal Company, strip, average crew 26; operated during last half of 1959 after receiving a military contract.

Suntrana Mining Company, Inc., underground, average crew 39.

Usibelli Coal Mine, Inc., strip, average crew 30.

Matanuska Field (Bituminous):

Castle Mountain Coal Company, strip, average crew 3; intermittent operation on a small scale.

Evan Jones Coal Company, underground, average crew 68; underground operations closed down in mid-year.

Minor Roop Strip, strip, average crew 61; subcontracting under Evan Jones Coal Company.

Mrak Coal Company, strip, average crew 33.

Pioneer Mining Company, Inc., strip, average crew 5; intermittent operation.

Point Barrow Field (lignite):

Meade River Coal Company, underground, average crew 12.

TABLE V-5. PRODUCTION OF COAL IN ALASKA, 1939 TO 1959

Year	Underground: Number of Mines	Underground: Production, tons	Stripping Operations: Number of Pits	Stripping Operations: Production, tons	Total Production, tons	Average Number of Employees
1939	3	148,417	--	--	148,417	88
1940	3	173,844	--	--	173,844	98
1941	3	238,960	--	--	238,960	153
1942	7	260,893	--	--	260,893	248
1943	5	289,232	--	--	289,232	251
1944	7	348,375	--	--	348,375	341
1945	5	297,644	--	--	297,644	335
1946	3	280,173	2	86,636	366,809	280
1947	2	294,758	2	66,462	361,220	261
1948	5	267,429	3	140,477	407,906	236
1949	3	335,867	4	97,666	433,333	314
1950	2	281,718	5	130,737	412,455	278
1951	2	261,974	4	232,359	494,333	253
1952	3	375,026	4	311,192	686,218	374
1953	3	426,841	6	434,630	861,471	399
1954	6	273,592	7	393,026	666,618	365
1955	6	239,571	7	400,125	639,696	264
1956	5	264,006	5	462,795	726,801	316
1957	4	297,744	6	544,594	842,338	333
1958	4	201,446	7	557,836	759,282	267
1959	3	--	9	--	602,000	288

Source: U. S. Bureau of Mines, Minerals Yearbooks; 1959 Report of the Division of Mines and Minerals, State of Alaska, preliminary.

In addition there were two one-man stripping operations in the Kenai Field, near Homer, which were operated intermittently. Coal (lignite) outcrops along the shore of Kachemak Bay, and has been loaded into boats and small scows at low tide, to be floated off to Homer and Seldovia at high tide.

During 1959, the status of commercial coal-mining activities underwent further change, and only one large underground mine, the Suntrana mine in the Nenana field, remained in operation. The Evan Jones underground mine ceased production midway in 1959, and all mining in the Matanuska field was carried on by stripping operations.

Commercial subbituminous coal from the Nenana field contains about 24 per cent moisture and has a heating value on the "as received" basis of from 8300 to 8700 Btu per lb. Its ash content on a dry basis is in the range of from 9 to about 13.5 per cent. Bituminous coal shipped under contract from the Matanuska field contains about 8 per cent moisture and has a heating value of about 12,400 Btu per lb. On the dry basis, the ash content is about 14 per cent. In 1958, 42.6 per cent of the coal mined in Alaska was mechanically cleaned. At the three cleaning plants involved, 36.9 per cent of the weight of the raw coal was discarded as refuse.

The average value per ton, fob mines, was $9.13 for Alaskan coals in 1958, compared to an average of $4.86 for all United States production. Prices of coal (fob mine) for military contracts during fiscal year 1958 ranged between $6.13 and $6.96 per ton for subbituminous coal from the Nenana field, and between $12.65 and $12.98 per ton for bituminous coal from the Matanuska field. Oddly enough, average mine value of coal strip-mined has been higher ($8.80 and $9.28 per ton in 1957 and 1958, respectively) than that mined underground ($8.41 and $8.72 per ton in 1957 and 1958, respectively).

Northwestern Canada

Coal has been produced in Yukon Territory for a number of years in amounts totaling a few thousand tons annually. Some lignite has been mined in the Dawson district and along the route of the Alaska Highway, but the chief producing mine in recent years is located in the Carmacks area where coal of bituminous rank is mined. Production of bituminous coal in Yukon Territory totaled 7,731 tons in 1957, and 4,344 tons in 1958. There are no producing coal mines listed for the portion of the Northwest Territories of interest in this study, although a small mine has operated in the Arctic area at Moose River to supply coal for a Government station at Aklavik.

In British Columbia, in the area north of the Canadian National Railway line to Prince Rupert, three coal mines were listed in the 1958 Report on Coal Mines in Canada. Two of these, in the Peace River coal fields, produced a total of about 5,000 tons of bituminous coal in 1957. One mine in the Telkwa area produced another 5,000 tons of coal in the same year. No production is listed for the coal fields of Alberta included in the area of concern for this study, although there has been some limited mine development in past years.

Reserves

Figure V-11 shows the location of the principal coal fields in Northwest North America according to the rank of the coal in place and the approximate extent of the field. Isolated known occurrences of coal in Alaska, where information required to delineate boundaries of the occurrences is lacking, are indicated by small crosses.

Alaska

Table V-6 lists the estimated original reserves of coal in Alaska according to the most recent reports of the U. S. Geological Survey. The rank of the coal reserves is shown for the several principal coal fields, with production to date in each. For the most part, these reserves are inferred on the basis of general reconnaissance surveys; only the reserves listed for the Jarvis Creek field, small portions of the Nenana, Broad Pass, and Kenai fields, and about half of the Matanuska field are based on detailed surveys. Thus, the reserves shown are useful chiefly only for indication of the order of magnitude of the coal believed to be present. The largest of the inferred reserves, about 85 per cent of the total, are shown to occur in the Northern Alaska field, north of the Arctic Circle. Even these listings are probably conservative, and future detailed surveys might well reveal larger tonnages. Coal recoverable by usual mining practices would be approximately half of the tonnages listed.

TABLE V-6. ORIGINAL RESERVES AND PRODUCTION OF ALASKA COAL FIELDS[a]

Millions of Short Tons

Coal Field	Original Reserves: Bituminous Coal	Subbituminous Coal and Lignite	Anthracite and Semianthracite	Total	Production to January 1, 1959
Northern Alaska[b]	20,000	60,000	--	80,000	(c)
Nenana[d]	--	5,000	--	5,000	6.6
Jarvis Creek[e]	--	73	--	73	None
Broad Pass[d]	--	63	--	63	(c)
Matanuska[d]	201	--	1	202	4.8
Kenai[d]	--	2,400	--	2,400	(c)
Bering River[b,f]	1,100	--	2,100	3,200	(c)
Others[b]	100[g]	3,600[h]	--	3,700	(c)
Total	21,401	71,136	2,101	94,638	11.9

(a) Source: U. S. Geological Survey.
(b) Reserve figures are based on reconnaissance surveys and indicate general order of magnitude only.
(c) Less than 100, 000 tons.
(d) Reserve figures based on detailed survey of part of each field and reconnaissance survey of remainder. Reserves based on detailed surveys include 1 billion tons in the Nenana field, 13 million tons in the Broad Pass field, 102 million tons in the Matanuska field, and 400 million tons in the Kenai field.
(e) Reserve figures based on detailed survey.
(f) Available data suggest that most of the coal in the Bering River field probably is too badly crushed and faulted to be economically recoverable.
(g) Includes the Herendeen Bay and Chignik fields.
(h) Includes the Eagle, Susitna, and Unga Island fields.

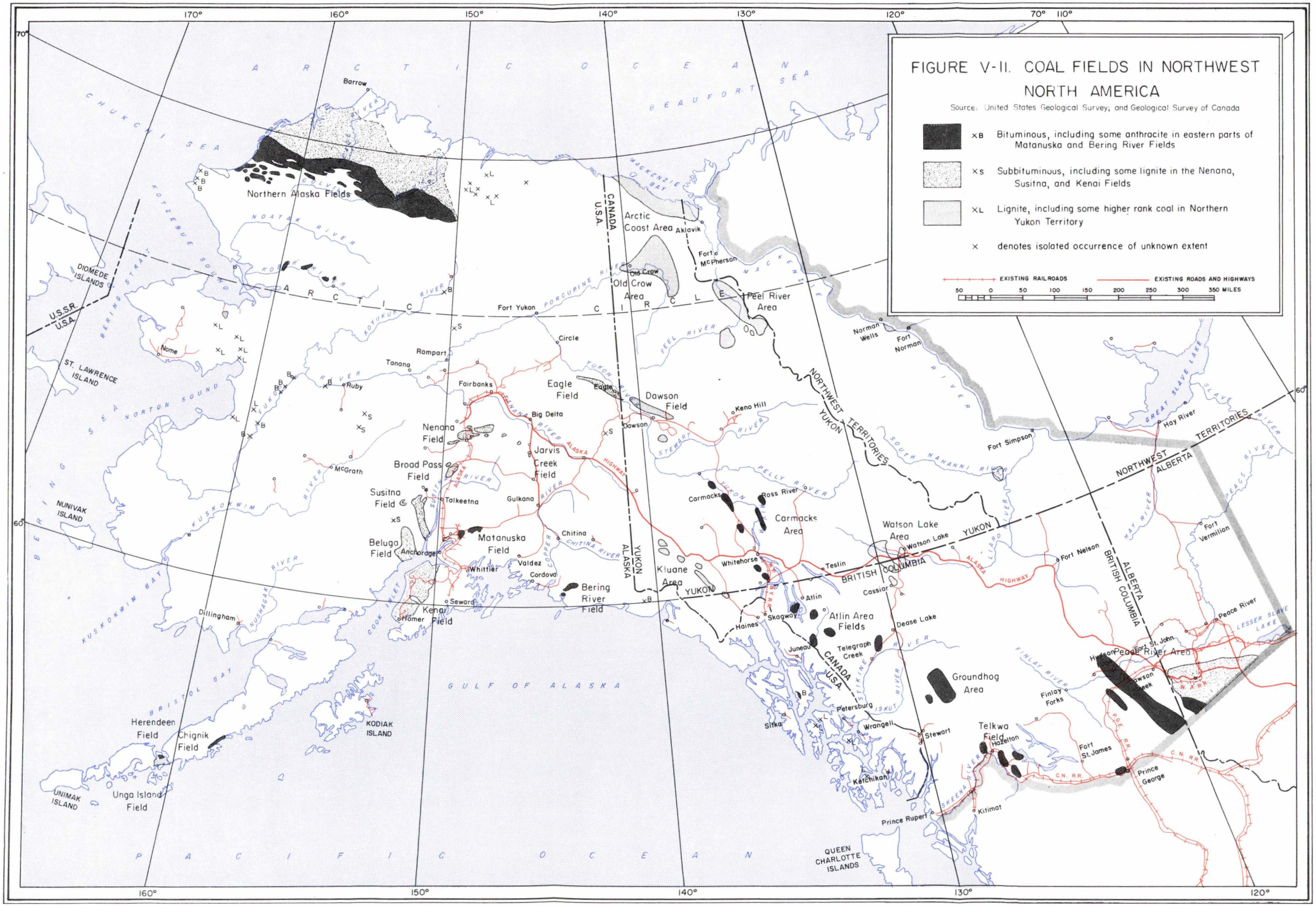
FIGURE V-II. COAL FIELDS IN NORTHWEST NORTH AMERICA
Source: United States Geological Survey; and Geological Survey of Canada
×B Bituminous, including some anthracite in eastern parts of Matanuska and Bering River Fields
×S Subbituminous, including some lignite in the Nenana, Susitna, and Kenai Fields
×L Lignite, including some higher rank coal in Northern Yukon Territory
× denotes isolated occurrence of unknown extent
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
A R C T I C O C E A N
CHUKCHI SEA
BEAUFORT SEA
Barrow
Northern Alaska Fields
Arctic Coast Area
Aklavik
Fort McPherson
Old Crow Area
Peel River Area
ARCTIC CIRCLE
Fort Yukon
Circle
Rampart
Tanana
Ruby
Nome
Fairbanks
Eagle Field
Dawson Field
Dawson
Keno Hill
Big Delta
Nenana Field
Jarvis Creek Field
Broad Pass Field
McGrath
Susitna Field
Talkeetna
Gulkana
Beluga Field
Anchorage
Matanuska Field
Chitina
Valdez
Whittier
Cordova
Bering River Field
Seward
Kenai Field
Homer
Dillingham
Carmacks
Ross River
Carmacks Area
Whitehorse
Kluane Area
Teslin
Watson Lake Area
Watson Lake
Atlin
Atlin Area Fields
Skagway
Haines
Juneau
Telegraph Creek
Dease Lake
Cassiar
Groundhog Area
Petersburg
Wrangell
Sitka
Stewart
Ketchikan
Prince Rupert
Kitimat
Telkwa Field
Hazelton
Fort St. James
Prince George
Finlay Forks
Hudson Hope
Fort St. John
Dawson Creek
Peace River Area
Peace River
Fort Vermilion
Fort Nelson
Fort Simpson
Hay River
Norman Wells
Fort Norman
GREAT SLAVE LAKE
LESSER SLAVE LAKE
ALASKA HIGHWAY
NORTHWEST TERRITORIES
YUKON
BRITISH COLUMBIA
ALBERTA
CANADA
U.S.A.
U.S.S.R.
DIOMEDE ISLANDS
ST. LAWRENCE ISLAND
NUNIVAK ISLAND
BERING SEA
NORTON SOUND
KOTZEBUE SOUND
BRISTOL BAY
KUSKOKWIM BAY
COOK INLET
GULF OF ALASKA
KODIAK ISLAND
Herendeen Field
Chignik Field
Unga Island Field
UNIMAK ISLAND
QUEEN CHARLOTTE ISLANDS
P A C I F I C O C E A N
C.N. RR.
P.G.E. RR.

The principal coal fields of Alaska are described briefly below.

Northern Alaska Fields. Extensive deposits of coal are present in the area north of the Brooks Range and the Arctic coast from the northern part of Cape Lisburne eastward for a distance of 300 miles or more. The coal in the southern part, nearest the Brooks Range, is bituminous in rank and closely folded; in the northern subbituminous coal area, the beds are more nearly flat. Between Corwin and Wainwright are a large number of beds of coal more than 3 feet in thickness; one is 20 feet thick. Beds of bituminous coal are also known in the Kobuk River Valley, south of the Brooks Range, and a few scattered beds of lignite are located in the area of the Koyukuk River. Outcrops of bituminous coal are also present along the Yukon River downstream from Nulato.

Nenana Field. The Nenana coal field south of Fairbanks is traversed by the Alaska Railroad near its western end. The coal is of subbituminous rank and has been mined extensively, particularly for heat and power uses in the Fairbanks area and adjacent military bases. Some of the beds of coal in this area are from 20 to 40 feet thick.

Jarvis Creek Field. This is a small subbituminous coal field located on Jarvis Creek, east of Donnelly on the Richardson Highway. The coal has not been mined commercially.

Broad Pass Field. The Broad Pass field is located near the Alaska Railroad at Costello Creek, midway between Anchorage and Fairbanks. Lignite and subbituminous coal are present. Some development work has been done in this area, but no commercial mines are currently in operation.

Matanuska Field. This field lies in a depression between the Talkeetna and the Chugach Mountains northeast of Anchorage. The coal is of bituminous rank and the field is one of the two active producing areas in Alaska. The producing mines are located in the lower part of the Matanuska Valley, in the Eska and Moose Creek fields. A number of mines have been developed and operated in the Matanuska field, first as underground mines and more recently as stripping operations. Some of the coal in the Upper Matanuska Valley is of coking grade.

Kenai Field. Coal-bearing formations cover most of the lowlands of the northwestern half of the Kenai Peninsula, where they are generally covered by variable thicknesses of glacial deposits and vegetation. The coal is subbituminous in rank, and exists in beds of from 3 to 6 feet in thickness. Some coal is mined for local use by small stripping operations operated intermittently.

Bering River Field. The Bering River coal field is located north of the head of Controller Bay, about 50 miles east and a little south of Cordova. A number of coal beds underlie an area of roughly 50 square miles. The coal is semibituminous in rank in the western part of the field and changes in character to anthracite in the eastern part.

The semibituminous coal is believed to be of good coking quality, and present interest in the field is largely on this account. Because much of the coal has been severely crushed and sheared by folding and faulting, the coal is friable and mining conditions have been judged difficult. The Jewell Ridge Coal Company of Virginia currently is engaged in an appraisal of coal quality and mining conditions in this area. Should the study show favorable results, further mine development will follow with markets in Japan and the West Coast for coking coals as the principal objective in an operation aimed at producing from 1 to 2 million tons of coking coal annually. This coal would have a value of about 10 dollars per ton at the tipple, and furnish employment for upwards of 400 to 700 men, depending upon the degree of mechanization possible.

Other Fields. Coal of bituminous quality also is found in the Chignik field and a portion of the Herendeen Bay field on the Alaska Peninsula. Subbituminous coal is present in the Eagle field, along the Yukon River near the Alaska-Yukon Territory border, the Unga Island and Herendeen Bay fields on the Alaska Peninsula, and the Susitna field near the head of Cook Inlet.

The Beluga field on the northwest side of Cook Inlet is of interest as a possible source of low-cost, strip-mined coal for electric-power generation. The area is currently being studied in more detail by the Geological Survey and the U. S. Bureau of Mines. There is evidence that large tonnages of subbituminous coal are available in seams up to 50 feet or more thick covered with from 10 to 150 feet of overburden. The coal has much the same analysis as coal from the Nenana area, with a slightly higher ash content and about the same heating value. Since the Beluga River area is only about 60 miles from Anchorage, interest has been displayed in the possibility of establishing a thermal-electric generating plant at the mine using relatively low-cost coal, and delivering power to the Anchorage area via a transmission line. Over-all costs of a power-producing system of this type have not yet been fully evaluated.

Northwestern Canada

Table V-7 shows the coal reserves of northwestern Canada according to estimates of the Canadian Geological Survey. The "probable" category includes reserves based on direct mining experience, drilling data or extensive geological data. "Possible" reserves are in addition to "probable" reserves and are based on less well-defined evidence. The total is expressed as "Mineable Coal". Again, if reserves of recoverable coal are to be designated, the amount should be reduced by one-half.

The reserves of this area are almost evenly divided between bituminous coal and the low-rank types. The largest reserves of lignite, some of which may be of higher rank, are located in the northern part of Yukon Territory. Most of the reserves of bituminous coal exist in northern British Columbia. The locations of the various coal fields are shown in Figure V-11.

TABLE V-7. COAL RESERVES OF NORTHWESTERN CANADA[a]

Millions of Short Tons

Province	Mineable Coal[b] Probable	Possible	Total
Yukon			
Bituminous	112	211	323
Lignite	323	1,239	1,562
Total	435	1,450	1,885
Northwest Territories			
Subbituminous[c]	3	13	16
British Columbia			
Bituminous	918	1,158	2,076
Lignite	--	12	12
Total	918	1,170	2,088
Alberta			
Subbituminous[d]	241	158	399
Grand Total	1,597	2,791	4,388

(a) Source: MacKay, B. R., "Coal Reserves of Canada", reprint of portion of report of the 1946 Royal Commission on Coal (1946).
(b) Recoverable coal is one-half of mineable coal.
(c) Includes some high-volatile C bituminous coal and lignite.
(d) Includes some high-volatile C bituminous coal.

Yukon Territory. Extensive deposits of lignite are believed to exist in the Peel River, Old Crow, and Arctic Coast districts. Deposits of lesser extent are found in the Kluane area in southern Yukon. About 100 miles east and northeast in the Carmacks and Whitehorse districts are found areas underlain by coal of bituminous rank.

Northwest Territories. Few known deposits of coal exist in the area of the Northwest Territories west of the Mackenzie River. A small area in the vicinity of Fort Norman is known to contain subbituminous coal. It is not improbable that coal measures underly other areas.

Northern British Columbia. Deposits of coal of bituminous rank totaling over 2 billion tons are believed to exist in the Atlin, Groundhog, Telkwa and Peace River coal areas. The last two areas contain some coal of coking grade.

Northwestern Alberta. The southern part of the portion of northwestern Alberta of interest to this study is underlain by seams of subbituminous coal. At the western edge, near British Columbia, the coal increases in rank and some may be classed as bituminous.

Markets for Alaskan Coal

Present Markets

By far the largest market for coal in Alaska is provided by the military installations located within its boundaries. Over 80 per cent of the coal is mined under Government contracts for use principally at Ladd and Eielson Air Force Base near Fairbanks, and at Fort Richardson and the Elmendorf Air Force Base near Anchorage. For these and other Government installations, contracts totaling over 700 thousand tons were awarded to coal producers in the Nenana and Matanuska fields during the 1958 fiscal year. The remainder of the coal mined was used for domestic heating and at local utilities and mining operations for producing steam and power. Coal is used in relatively few steam power plants in Alaska since the energy for most of the electric generating plants for limited industrial use and the various municipalities is supplied by hydro or diesel-engine installations.

Aside from that used at military installations the market for coal in Alaska at the present time is very limited. Once the largest consumer of coal, the Alaska Railroad has converted to diesel-electric motive power and its power supply at way stations is largely supplied by diesel-driven generators. There are no heavy industrial operations in Alaska such as cement or metallurgical plants which might add to the demand for coal.

With production of only a few thousand tons per year, the present markets for coal in the Canadian Northwest area covered by this study are small and of only local significance.

Prices

As mentioned previously, coal prices fob the mine are relatively high compared with prices in effect at mines elsewhere in the U. S. The high cost of labor, machines, and supplies is partially responsible for the higher prices. Geologic factors adversely affecting mining costs and lower yields of washed coal resulting from relatively high refuse losses are other factors leading to higher mining costs at the mine.

Subbituminous coal from the Healy field (Nenana) is delivered to the Fairbanks yards at a price of between $10 and $11 per ton. This would be the price for coal received by a large-scale user such as a utility or industrial power plant. The delivered cost of coal to commercial users through dealers is about $18 per ton in lots of 4 tons. Deliveries in smaller lots to retail customers, including handling or stowage charges would be somewhat higher. At Anchorage, the delivered cost at the railroad yards to industrial users is about $14 per ton for bituminous coal from the Matanuska field. Dealer margins, handling charges, and truckage costs add another $6 to $10 per ton for retail deliveries.

Fuel oil is formidable competition for coal for space-heating purposes, particularly at ocean ports or at towns farther inland with road or rail transportation. Fuel oil for residential and commercial heating bears a retail price of about 22 cents per gallon at Anchorage, and from 17.9 to 19.5 cents per gallon at Seward, Juneau, Sitka, and Ketchikan where coal either is not available or is sold at sacked-coal prices of about $40 per ton. Added transportation costs increase the retail price of fuel oil to 32 cents per gallon at Fairbanks.

Future Markets

As mentioned previously, the largest market for Alaskan coal is represented by the military steam and electric generating plants in the Anchorage and Fairbanks areas. This is the present base market. Continuation of this market depends upon policy decisions to be made by the Government departments involved should competitive fuels – natural gas, for instance – become available in the area for industrial use at lower equivalent cost than coal from present sources. Even should the use of coal at military-base power plants be continued, the maintenance of the present level of demand is not assured as changes in emphasis in the requirements for military installations in Alaska are made from time to time by the Department of Defense.

Any increased use of Alaskan coal will depend upon several factors, including the principal and obvious ones of (1) an expanded industrial development, (2) the availability and price of competitive fuels, and (3) decreased mining and transportation costs.

Coal, as a raw-material resource by itself, cannot be expected to foster increased markets. That is to say, the possibilities of establishing a coal-based industry involvinv carbonization, gasification or hydrogenation to produce coke, fuel gas, synthetic liquid fuels or coal chemicals are extremely remote. This is particularly true if the oil and gas potential of Alaska and northwestern Canada can be developed to the degree that many now visualize.

Perhaps the most obvious factor militating against the establishment of a coal-based industry for Northwest North America coals is the geographical location of coal fields. The large coal fields of western Canada and the U. S. are much closer to mainland-area markets for such products as may be required, and economic factors would dictate their earlier exploitation should the need arise. No export markets for Alaskan steam coal are foreseen.

Some of the coal in Alaska is of coking quality, capable of being used in blends for the production of metallurgical coke. The U. S. Bureau of Mines has estimated that perhaps 2 billion tons of coal in the Bering River and Northern Alaska fields fall into this category. Of immediate interest in this connection is the possibility of developing a source of coking coals for prospective markets on the West Coast of the United States or, more particularly, for export to Japan. The Japanese are in need of an additional source of coking coal, and are interested in Alaskan sources. An intensive investigation of the Bering River coal field is being conducted by the Jewell Ridge Coal Company of Virginia with the view of assessing the suitability of the low-volatile coals for making metallurgical coke and the engineering factors involved in the development of a large-scale mining operation. Severe structural deformation of many of the coal beds in this area is a complicating factor making it necessary for a careful study before making financial commitments for commercial mine development.

Except for the possibility of establishing an export business for coking coal, any significant expansion in the coal industry of Alaska must be based on the establishment of industries that are substantial fuel users. There is much less likelihood that the establishment of industries requiring large amounts of electric power will benefit the coal industry as it has in the U. S. The large hydropower potential of Alaska, as well or perhaps even better distributed than the coal fields, makes it more likely that the relatively low-cost power required will come from such sources. A further competitive influence militating against the development of coal resources, large though they are, is the promising gas and oil potential of the area, especially on the Kenai Peninsula that is near the large Anchorage markets for Matanuska coal.

Markets for the Coal of Northwestern Canada

As mentioned previously, the production of coal from the area of northwestern Canada under study has been very small, less than 20,000 tons annually. The situation with respect to the possibilities of future development and use of the available coal reserves is much the same as that for Alaskan coals; that is, the increasing availability of oil, gas, and hydropower as competing sources of energy and the lack of resource-based industries which are substantial fuel users.

Some interest has been shown in the iron ore deposits in the Hines Creek area of northwestern Alberta. This ore is relatively low grade and is high in silicon, but studies have shown that a concentrate suitable for use in a blast furnace can be prepared and that the ore can be smelted by reduction processes such as prereduction-electric-smelting, the Krupp-Wren, or by other sponge iron processes using natural gas. Coal for reduction might be obtained from the same general area. The high quality low-volatile bituminous coals in the Portage Mountain area on the Peace River would also be available.

Transportation Factors

Except as local deposits of coal served local needs for space heating and steam raising, coal mining as an industry in Alaska awaited the building of the Alaska Railroad before its potential could be exploited. This railroad now serves the Nenana and Matanuska fields and gives access to the Broad Pass field. The development of the Alaska Railroad occurred at a time when convenient access to coal fields was a requirement to satisfy the fuel needs of motive power, and for many years the railroad was the principal coal customer of the area. With dieselization, oil became the prescribed fuel, and to the railroad, coal became a factor only of freight revenue. Because coal is not required for operation, whether or not the railroad traverses or reaches a coal field is only of revenue interest, and the coal traffic originates only in response to the market demand in the territory served by the railroad. To attempt to make an assessment of transportation needs specifically in relation to coal fields is not pertinent until industrial needs can be specified. Coal itself probably should be considered as an ancillary resource except as it or a derived product assumes a prime commodity status either on an internal or export basis.

Thus, there will be transportation needs for the Bering River coal should the field be developed for export trade. This, however, is of chiefly local or immediate significance and the development of a transport system from the mine to a port area, whether by rail, truck, conveyor, or pipeline, is only one localized part of the whole development effort.

Potential Impact on Area's Economy

In terms of mineral production in Alaska, coal is second only to gold in value, the respective values for 1959 production being $5,558,000 and $5,985,000. Of the total value of mineral production, excluding sand and gravel which sometimes are included for statistical purposes, coal accounted for almost 40 per cent.

With development of the gas and oil potential of Alaska and northwestern Canada, and with the large hydroelectric potential of the area, a strong growth of the coal industry in either area is unlikely and the impact of coal on the Area's economy probably will be supplementary at best. The best prospect for growth in coal's contribution to the economy of Alaska lies in the development of coking coal reserves for export. Barring this, a significant increase in markets for coal will occur only as heavy fuel-consuming industries enter the picture. Even for these markets, coal will face heavy competition from hydroelectric power, oil, and natural gas. If plans for the development of coking-coal deposits in the Bering River area materialize, the production of coal could more than double within the next 10 years. If this development does not occur, it is not unlikely that coal production could reach a "status quo" plateau which is dependent chiefly on contracts for military installations.

Other potential new outlets for coal in the future lie in its possible use in the combination pretreatment-electric furnace smelting of iron ore at Klukwan or Snettisham, and in its possible use in smelting copper ores at Kobuk, as discussed briefly in the foregoing "Metals and Minerals" section. One might visualize consumption of some 450,000 tons of coal, for example, at Klukwan in the production of 1 million tons of steel per year, and perhaps 75,000 tons of coal in producing say 60,000 tons of blister copper at Kobuk annually. Coal for Klukwan could be coking grade from Bering River, for example, or noncoking grade from Matanuska or possibly even Beluga River. The small deposits of bituminous-grade coal shown near Kobuk on Figure V-11 might possibly serve the potential smelting need there — at any rate, such coal would have to occur relatively close to the copper-mining operation.

OIL AND GAS

Northwest North America, containing a number of sedimentary basins, is one of the few remaining areas on the North American continent offering the promise of holding large-scale deposits of oil and gas. The successful northwestward march of drilling activities from the petroliferous regions in Alberta and British Columbia appears to indicate great potentials in the sedimentary basins extending farther northwest and west in Yukon Territory and Alaska.

Alaska

In Alaska there are over 60 million acres contained in possible petroleum provinces south of the Brooks Range. North of the Brooks Range there are about 40 million acres of possible petroleum land, approximately half of which lies in Naval Petroleum Reserve No. 4. Figure V-12 shows the location of these possible provinces based on work by the U. S. Geological Survey[1].

There is, of course, no way of determining which of these provinces may contain petroleum in commercial quantities and the extent of the reserves within this vast area prior to the actual finding of oil and its development. Wide variations occur throughout the world in the extent of oil present in any given area, and at the present stage of development of Alaska's oil industry, no attempted correlation of the oil that might be present per acre with the acreage of possible petroleum provinces would be meaningful. On the other hand, the potential must be presumed to be quite large. If a reasonable number of the various sedimentary basins are found to contain major deposits of economically recoverable petroleum, ultimate reserves of several billion barrels of oil are well within the realm of possibilities.

Alaska has been divided into southern, central, and northern major geologic-physiographic regions by the U. S. Geological Survey for the purpose of appraising its petroleum possibilities.

> "Southern Alaska, an area of 185,000 square miles, includes the arcuate mountain chain formed by the Alaska and Aleutian Ranges and the Mentasta-Nutzotin Mountains, the coastal range-and-valley area to the south, and the southeastern Alaska 'panhandle'.
>
> "Central Alaska is a region of about 275,000 square miles and consists of an irregular assemblage of intricately dissected uplands and alluvium-floored lowland basins. Scattered peaks of resistant intrusive igneous rocks surmount most of the upland areas.
>
> "Northern Alaska includes the Brooks Range and all the treeless tundra north to the Arctic coast, an area of about 125,000 square miles."[1]

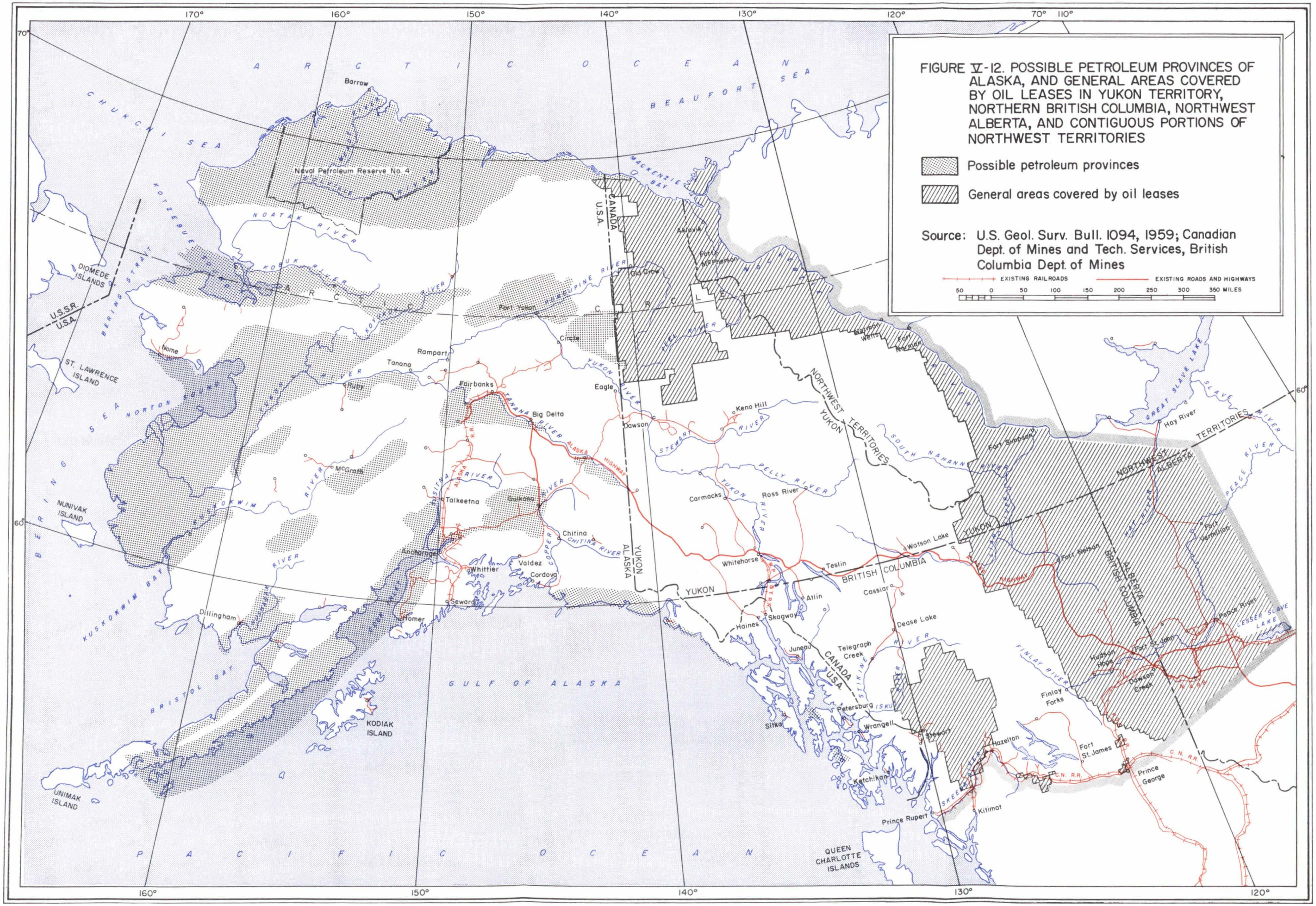

FIGURE V-12. POSSIBLE PETROLEUM PROVINCES OF ALASKA, AND GENERAL AREAS COVERED BY OIL LEASES IN YUKON TERRITORY, NORTHERN BRITISH COLUMBIA, NORTHWEST ALBERTA, AND CONTIGUOUS PORTIONS OF NORTHWEST TERRITORIES

Source: U.S. Geol. Surv. Bull. 1094, 1959; Canadian Dept. of Mines and Tech. Services, British Columbia Dept. of Mines

Historical Development

Development of an oil and gas industry within Alaska has been slow and spasmodic. Oil seeps have been known to exist there since before Col. Drake drilled the first oil well in Pennsylvania in 1859. The start of the Alaskan oil industry, however, might be said to have occurred in 1892 when a prospector named Edelman staked a claim on the Iniskin Peninsula on the west side of Cook Inlet.(1)

Edelman's claims were abandoned, but shortly thereafter other claims were staked on the Iniskin Peninsula and in the Katalla and Yakataga districts. Shallow drilling was undertaken intermittently during the next 25 years in these and other areas in the vicinity of oil and gas seeps, and in other areas where surface indications of petroleum were not reported. Results of these efforts were indifferent, the small Katalla field being the only commercial success.

Several exploratory wells were drilled in the early and mid-twenties, almost entirely along the southern coastal areas, but exploration activities were at a virtual standstill in the early 30's when the small refinery at Katalla burned and that field was shut in.

From 1933 to 1955, little active exploration was undertaken in southern Alaska. In all, five wells were drilled and abandoned and drilling was suspended on three other wells. Total footage drilled was 50,026 feet, and the deepest well was the Phillips Petroleum-Kerr McGee Sullivan No. 1, drilled in the Yakataga district and abandoned at 10,013 feet.(1)

In all of central Alaska through 1955, only six wells are known to have been drilled, the deepest being 350 feet. No commercial production was found.(1)

The historic development of northern Alaskan exploration is concerned primarily with Naval Petroleum Reserve No. 4. This reserve, established by executive order of President Harding in 1923, comprises about 37,000 square miles (shown in Figure V-12). A comprehensive history of the exploration of this region has been published.(2) Prior to 1944, investigation of the region had been limited to a few geological parties. Starting in 1944 and ending in 1953, however, an intensive effort was made to explore this region. Results of extensive geological, geophysical, aerial mapping, and test drilling, costing $47.6 million, yielded:

(1) Discovery of three oil fields (Umiat, Simpson, and Fish Creek).

(2) Discovery of several gas fields, the Gubik field being the only proved field of major size, having reserve estimates of 22 billion cubic feet in tested sands and 295 billion cubic feet of untested sands having similar characteristics.

A news release issued by the U. S. Department of the Interior, October 13, 1959, states that known oil reserves on Naval Petroleum Reserve No. 4, recoverable by primary means, are estimated to be 122 million barrels. An additional undetermined but substantial amount should be recoverable by carefully engineered secondary recovery methods from the relatively shallow Umiat field. Total oil in place is estimated at over 930 million barrels.(3)

Modification of federal regulations and the growing difficulties in finding suitable acreage blocks for oil exploration in the U. S. at a reasonable cost, led to a reawakening of oil-industry interest in Alaskan possibilities in the mid-1950's. A number of the major oil companies obtained leases, and exploration was renewed using modern equipment and techniques. The discovery by Richfield Oil Corporation on the Swanson River, Kenai Peninsula, in July, 1957, was the first indication that oil in commercial quantities exists in southern Alaska.

This discovery sparked a lease play that has been intensified by the shifting of Alaska to statehood. Continued drilling of this field by Standard Oil Company of California, as operator in a joint venture with Richfield (including minor interests held by Union Oil Company and The Ohio Oil Company), has resulted in six more producing wells, and the field is still far from delineated.

Early in 1960, Standard Oil Company of California made a new discovery on their Soldotna Creek lease (owned jointly with Richfield Oil Corporation) just south of the Swanson River unit. The Soldotna Creek find is an extension of the Swanson River field. This discovery well had a test flow of 1900 barrels per day through a 3/4-in. choke. Announcement has been made of the completion of a second producing well, having an estimated maximum economic recovery (MER) of 700 to 800 barrels per day, and a third well was being tested in August, 1960.

In combination with the Swanson River unit's potential production, sufficient reserves had been found to justify a pipeline to tidewater. Standard Oil Company announced plans in June, 1960, for a 20-mile 8-inch pipeline having a capacity of 10,000 barrels per day from the Swanson River and Soldotna Creek wells to Nikiska on Cook Inlet at an estimated cost of $4 million.(4) The line was completed and placed in operation in October, 1960.

Union Oil Company and The Ohio Oil Company discovered a major gas field in October, 1959, on their holdings 6 miles south of Kenai.(5) The initial well tested 31 million cubic feet per day through a 7/8-in. choke.(6)

This well was drilled to 15,047 feet and a number of potentially productive gas sands were encountered. Actual production is obtained from a perforated zone from 4455 to 4590 feet.(6) Two additional wells have been drilled, extending the field for 2-1/2 miles north and assuring that the field is a major discovery. A contract has been made with the Anchorage Natural Gas Corporation to supply gas for the city of Anchorage, and a gas pipeline to Anchorage and distribution system within Anchorage are now under construction. The capacity of these three wells is deemed sufficient to meet the contract demands at present. Reserves are estimated to be considerably in excess of the amounts dedicated to the Anchorage Natural Gas Corporation for supplying Anchorage. Plans have been made to return a drilling rig to this area late in 1960 to continue development operations and to test other areas in the Union-Ohio holdings as a basis for establishing proved reserves for potential markets for the natural gas. Standard Oil Company of California is also testing gas sands in the Swanson River area, which are known to contain large quantities of gas. Also the Halbouty Alaska Oil Company has encountered several gas sands in its exploratory well being drilled on a site 15 miles west of the Swanson River field and 12 miles north of the Kenai field.(7) A second well has just been spudded.

Sixteen wells were spudded throughout the State during 1959, while drilling was continued on four other wells. The footage drilled, as reported by the operators, totaled 137,902 feet. Statistics on this drilling activity are shown in Table V-8. In addition, Pan American Petroleum Corporation drilled a 1200-foot core test about 30 miles west of Bethel. Also in 1959, Benedum and Associates moved a rig from Point Barrow to its holdings in the Koyukuk Basin near Nulato, approximately 350 miles east of Nome.(8) This was the first deep drilling operation in central Alaska, reaching a depth of 12,015 feet. No oil or gas was found, however, and the well was plugged and abandoned, May 29, 1960.

Seven geophysical exploration companies operated in Alaska in 1959, and seismic crew months totaled 92.0, while gravity meter crew months totaled 7.5. A marine seismic survey of Cook Inlet was completed in May after 4 months of shooting (done at this time to avoid salmon runs). Eighteen oil companies had a total of 36 geologic field parties and the U. S. Geological Survey had two parties in the field. According to reports submitted to the State of Alaska, exploration expenditures amounted to $16,714,000, and drilling and production costs totaled $13,940,000 in 1959.

Alaska's first competitive lease sale, covering 77,831 acres of offshore areas in Cook Inlet, as announced by the State, resulted in an average acre-bid of $51.66, totaling $4,021,031.43, which was appreciably higher than had been contemplated. A second lease sale held in July, 1960, by the State of Alaska of 16,505 acres of State and University lands and offshore acreages in the Cook Inlet area resulted in an average acre-bid of $24.70, totaling $407,654.54.

On February 24, 1960, the U. S. Department of the Interior held competitive bids on 9,105 acres in the area of the Gubik gas field, adjacent to Naval Petroleum Reserve No. 4. Bids totaled $206,027.10, an average of $22.63 per acre. Under terms of statehood, 90 per cent of this revenue goes to the State of Alaska.

During 1960, six to eight drilling rigs will be operating in various possible petroleum provinces, and 22 geological field parties will be exploring even more widely scattered possible petroliferous lands.

In addition, Polaris Exploration Company has recently announced an agreement with the Teikoku Oil Company, Ltd., of Tokyo, for a joint expenditure of $1.25 million for geophysical work in the Kenai Peninsula-Cook Inlet area August or September, 1960, and starting of an exploratory well by the end of 1960.(9)

Development contracts approved by the U. S. Department of the Interior now number eight, comprising about 4.6 million acres. Shell Oil Company's is the most recent, covering approximately 450,000 acres in an area 90 miles southwest of Bethel, bordering the north coast of Kuskokwim Bay. Shell is committed to spend a minimum of $950,000 and relinquish half of the acreage by January 1, 1964.(10) Other contracts approved in 1959 include:

Richfield Oil Corporation – Katalla-Yakataga area – 571,121 acres adjoining 490,000 acres already under development contract

Union Oil-Ohio Oil – Knik Arm area – 229,000 acres

General Petroleum – Becharof-Egejik area – 455,573 acres

Pan American Petroleum Corporation – Napatuk Creek area – 465,280 acres.

TABLE V-8. OIL- AND GAS-WELL ACTIVITY IN ALASKA, 1959[(a)]

Operator	Well No.	1/4 Sec.	Twp.	Range	B & M	Spud Date	Completion Date	TD, ft	Status 12-31-59
Anchorage G & O Dev. Co.	Rosetta (1)	NW 20	18N	3W	S	6 -54		4260	DSI[(b)]
Alaska Consolidated Oil Co.	Beal (1)	NW 17	5S	23W	S	8- 4-54		9746	WO[(c)]
Anchorage G & O Dev. Co.	Rosetta (3)	SW 21	18N	3W	S	7-25-56		6109	DSI[(d)]
Humble O & R Co.	Bear Creek Unit (1)	SE 36	29S	41W	S	9-23-57	3- 4-59	14375	P&A
Colorado O & G Corp.	Yakutat (3)	SE 3	28S	34E	CR	7-21-58	4-23-59	10494	P&A
Alaska Consolidated Oil Co.	Iniskin Unit-A. Zappa (1)	NE 18	5S	23W	S	12-25-58		11200	DSI[(e)]
Standard Oil Co. of Cal.	Swanson River Unit (34-16)	SE 16	8N	9W	S	1- 4-59	3-26-59	12582	P&A
Standard Oil Co. of Cal.	Swanson River Unit (14-15)	SW 15	8N	9W	S	3-29-59	7-25-59	11460	POW[(f)]
Halbouty Alaska Oil Co.	Halbouty-King (1)	SE 6	7N	9W	S	1-31-59	5-13-59	12037	P&A
Union Oil Co. of Cal.	Kenai Unit (14-6)	SW 6	4N	11W	S	5-28-59	10-11-59	15047	GSI
Standard Oil Co. of Cal.	Swanson River Unit (12-27)	NW 27	8N	9W	S	7- 4-59	11-30-59	11500	POW
General Petroleum Corp.	Great Basins (1)	NE 2	27S	48W	S	7- 6-59	9-14-59	11080	P&A
Standard Oil Co. of Cal.	Swanson River Unit (32-15)	NE 15	8N	9W	S	8- 5-59	10-24-59	11982	POW[(g)]
Anchorage G & O Dev. Co.	Rosetta (4)	NW 21	18N	3W	S	8-24-59		1614	DSI[(h)]
General Petroleum Corp.	Great Basins (2)	NE 35	25S	50W	S	10-10-59	11-11-59	8865	P&A
Union Oil Co. of Cal.	Kenai Unit (34-31)	SE 31	5N	11W	S	10-28-59	11-24-59	5809	GSI
Standard Oil Co. of Cal.	Swanson River Unit (32-22)	NE 22	8N	9W	S	10- 3-59		11773	Drlg
Union Oil Co. of Cal.	Kenai Unit (33-30)	SE 30	5N	11W	S	11-28-59	12-21-59	5011	GSI
Benedum & Associates	Nulato Unit (1)	SW 7	10S	2E	KR	11-29-59		1850	Drlg
Richfield Oil Corp.	Kaliakh River Unit (1)	SW 34	20S	14E	CR	12- 3-59		5493	Drlg
Standard Oil Co. of Cal.	Swanson River Unit (14-27)	SW 27	8N	9W	S	12-26-59		2900	Drlg[(i)]
Standard Oil Co. of Cal.	Soldotna Creek Unit (41-4)	NE 4	7N	9W	S	12-31-59		251	Drlg

Note: DSI - drilling suspended indefinitely; WO - workover; P&A - plugged and abandoned; GSI - gas well shut in; POW - producing oil well; Drlg - drilling.
S - Seward Baseline and Meridian; CR - Copper River Baseline and Meridian; KR - Kateel River Baseline and Meridian.

(a) Source: Alaska International Rail and Highway Commission.
(b) DSI 6-30-59. Deepened from 4049 to 4260 feet.
(c) Havenstrite Oil Co. well spudded 8-4-54. Hydrofractured 11-59.
(d) DSI 10-58. No progress on attempt to recover fish during 7-59.
(e) DSI 10-59, unrecoverable fish.
(f) Surface location SE/4, Sec. 16; sidetracked out of SRU 34-16 at 3759 feet to total depth of 11460 feet.
(g) Surface location NW/4, Sec. 15.
(h) DSI 10-13-59.
(i) Surface location NW/4, Sec. 27.

Acreage under lease at the end of 1959 amounted to almost 33 million acres, largely under federal oil and gas leases, while total acreage in geologic provinces south of the Brooks Range amounted to 60,400,000 acres. Estimates of land revenues from various sources compiled by the Alaska Division of Lands are shown in Table V-9.

Future Outlook

As of mid-1960, the future for an Alaskan oil industry looks promising but uncertain as to magnitude. There is little question that there will be considerable income for the State from leases, rentals, and royalties on presently held land and as new territory is opened.

Dalton, in his comprehensive survey on the possible future growth of the petroleum industry in Alaska(11), has estimated that $450 million would be required to make "a fair appraisal of the scale of exploration needed to determine whether or not the potential reserves of oil in the various possible petroleum provinces of Alaska may exist and are worthy of developments". He goes on to assume that one-half of total effort will be made within the decade 1958-1967. If major discoveries are made in areas other than the Cook Inlet region, this estimate of expenditures by 1967 may prove to be conservative. On the other hand, it must be recognized that the presently discovered oil and gas fields on the Kenai Peninsula do not, in themselves, make a major petroleum area, although gas reserves may be inferred to be many times Alaska's foreseeable needs during the next 20 years. Thus, results of the active exploration efforts that will be undertaken during the next 3 to 5 years will largely determine the course of Alaska as a major oil state.

On the basis of present information, oil and gas appear to offer great promise of providing a major, sound economic base for long-range growth and development of the 49th state, but there are serious problems that must be faced. Not the least of these is the high cost of drilling and exploration. Beckwith has made comparisons between costs for drilling on the Kenai Peninsula and typical costs in California, shown in Table V-10.(12) It is apparent that minimum costs of drilling in the Kenai area, exclusive of the cost of moving rig, are almost double those in California, and the accessibility of the Kenai probably makes it the lowest cost area in Alaska. Coleman, in his discussion of logistics in the Yakutat area, points up the special equipment needed and the high shipping costs for materials and equipment, amounting to $90 per ton over-all.(13) Obviously, many of the factors are strictly the result of Alaska being so far from supplies and markets, but it means that major oil fields with higher production rates will be needed for Alaskan oil to be competitive under present conditions of world oversupply of oil. Also, added incentives must be made available wherever possible to encourage the oil companies in their exploration efforts.

In this connection, it might be noted that opening Naval Petroleum Reserve No. 4 to private development under competitive bidding would assist in developing adequate productive capacity north of the Brooks Range to effect commercial operations at an earlier date than might be possible otherwise. During the last session of Congress, Senator Bartlett introduced a bill with this view in mind. The U. S. Department of the Interior, in a recent news release, announced its support of the proposed legislation which would abolish Naval Petroleum Reserve No. 4 and transfer jurisdiction of the area from the Navy Department to the Department of the Interior.(14)

TABLE V-9. LAND-REVENUE ESTIMATES[(a)]

In Thousands of Dollars

	Federal Oil, Gas, and Coal		State Transactions
	Computed Rentals on Existing Oil, Gas, and Coal Leases	Estimated Rentals and Royalties on Pending and New Oil, Gas, and Coal Leases	Estimated Bonus Bids and Rentals on Noncompetitive and Competitive Oil and Gas Leases
1959 (1st half)			
1959 (2nd half)	3,424.	11.	
1960 (1st half)	1,411.	586.	300.
1960 (2nd half)	912.	860.	900.
1961 (1st half)	960.	400.	1,000.
1961 (2nd half)	2,313.	450.	1,100.
1962 (1st half)	1,559.	700.	900.
1962 (2nd half)	5,868.	1,246.	1,000.
1963 (1st half)	3,007.	1,750.	1,050.
1963 (2nd half)	6,980.	1,496.	1,150.
1964 (1st half)	3,719.	1,750.	1,250.
1964 (2nd half)	7,552.	1,496.	1,350.
1965 (complete)	11,010.	3,246.	1,750.
1966 (complete)	10,700.	3,246.	1,900.
1967 (complete)	9,398.	3,346.	2,000.
1968 (complete)	4,392.	3,446.	2,100.

(a) Source: Alaska Division of Lands, November 3, 1959.

TABLE V-10. COST APPROXIMATIONS FOR DRILLING A 10,000-FOOT EXPLORATORY WELL – ALASKA VERSUS CALIFORNIA[a]

Item	Kenai Peninsula Range		San Joaquin Valley
	Low	High	Average
Road (10 miles, Summer)	$ 50,000	$ 400,000	$ 30,000
Location (mat, sumps, water well, cellar)	20,000	50,000	10,000
Transport rig to Alaska (50 tons)	40,000	60,000	--
Haul rig to site (125 miles)	25,000	40,000	15,000
Rigging up (cranes, forklifts, crew)	20,000	30,000	5,000
Miscellaneous (conductor, lumber, trailer, etc.)	15,000	25,000	5,000
Drilling (includes direct supervision)			
Contractor (60 days)	150,000	200,000	90,000
Days to set surface pipe 7			
Days drilling 33			
Days coring, testing, logging 20			
Supplies	105,000	155,000	70,000
Bits - 75			
Mud - 250 tons			
Chemicals and additives - 50 tons			
Weighting material - 100 tons			
Cement - 5,000 sacks			
Fuel			
3,000 feet of 13-3/8-inch surface pipe			
Service Companies	35,000	60,000	25,000
Fishing tools			
Testing tools			
Coring tools			
Mud logging equipment			
Electric logging equipment			
Well surveying equipment			
Pipe straightening equipment			
Cementing heads			
Cementing equipment			
Miscellaneous other rented equipment			
Return rig to California	40,000	50,000	--
Total if Dry Hole	$500,000	$1,070,000	$250,000
Complete Well as Producer			
7-inch N-80 casing 5,000-lb tree	100,000	125,000	70,000
2-1/2-inch N-80 tubing 2-1000 bbl tanks and ICL			
Total if Economic Volumes of Oil Found	$600,000	$1,195,000	$320,000

(a) Source: Beckwith, Robert, "Alaska Operations", talk at Professional Group Meeting, AIME, Bakersfield, California (January 7, 1960).

Northwestern Canada

Historical Development

Development of the Canadian petroleum industry has occurred largely since World War II and serves as an example of the possibilities that excite the interest in Alaska and the Far North.

As late as 1947, Canada depended on imports to supply almost 90 per cent of its petroleum needs. The only major field was Turner Valley, west of Calgary, Alberta, originally discovered in 1914 and established as the first major oil field in the British Commonwealth during the mid-30's.

Following this, a heavy crude area was opened up along the Alberta-Saskatchewan boundary near Lloydminster. Another field, Norman Wells, located on the Mackenzie River in the Northwest Territories, had been discovered in 1920.(15) During World War II, the Norman Wells field was developed and a pipeline was constructed to supply oil to a refinery moved to, and erected at, Whitehorse, Yukon Territory. A detailed history of this highly controversial project is not pertinent to this study. The Norman Wells field, however, demonstrated that oil in commercial quantities was present in the Far North. Annual production reached a maximum of 1,229,310 barrels in 1944, almost triple present production rates. Cumulative production through 1959 amounted to 6,505,000 barrels. Proved reserves remaining at the end of 1959, as reported by the Canadian Petroleum Association, amounted to 51,970,000 barrels.(16)

Following the war, the refinery at Whitehorse was dismantled and moved to Edmonton, Alberta, and the Canol crude-oil pipeline to Whitehorse was abandoned, although the products line from Whitehorse to Skagway has continued to be used for distillate shipments from Skagway to Whitehorse. A small refinery, 1200 barrels per day of crude capacity, built at Norman Wells prior to the war, supplies refined products to meet local needs in the Northwest Territories, amounting to slightly more than 400,000 barrels annually. Figure V-12 shows the western boundary of acreage under lease or development contract. This corresponds roughly with the area containing possible petroleum provinces.

Alberta. Discovery of the Leduc field, near Edmonton, in 1947 sparked an oil boom in Alberta that has shown tremendous growth. Estimated expenditures by the oil industry, exclusive of petroleum refining and petrochemical plants, during the past several years in Alberta have been as follows:(17)

1951 - $219 million	1955 - $433 million
1952 - 315 million	1956 - 536 million
1953 - 330 million	1957 - 504 million
1954 - 366 million	1958 - 471 million

Most of these expenditures, however, were in the central and southern regions of Alberta; probably considerably less than 20 per cent of the total has been spent in the region covered by this study. A higher percentage will be spent in the latter area, however, as exploration activities move northward. Development of oil and gas has resulted in revenues for Alberta of $959.7 million from 1946-1959. Revenues in 1959 of $131.4 million were slightly under the record of $134.4 million in 1957. The 13-year figure includes:(18)

$510.4 million - sale of oil and gas rights

231.8 million - lease and reservation rentals

217.4 million - production royalties.

The Oil and Gas Conservation Board, in a Report of the Royal Commission on the Development of Northern Alberta, in 1958, made an estimate of the proven reserves and production of northern Alberta oil based on "the fact that there are some 100,000 square miles of prospective oil and gas lands in Northern Alberta and on the following three assumptions:

"1. Any large area of prospective oil and gas lands can be reasonably explored with a wildcat drilling density of one well per ten square miles. From this it could follow that approximately 10,000 wildcat wells would effectively explore the 100,000 square miles of lands.

"2. Virgin recoverable reserves of approximately 400,000 barrels may be expected, on the average, from the drilling of one wildcat well.

"3. The incentive for exploration and development in Northern Alberta will result in the continued drilling of some 100 to 150 wildcat wells each year or some 3,500 wildcat wells by 1980. On this basis the prospective oil and gas lands would be about 35 per cent developed by 1980. This compares with an estimated development of around 75 per cent for Alberta."

Table V-11 shows these estimates from 1949 to 1980.(19) The total recoverable reserves to be found by 1980 are estimated to be 1.4 billion barrels. Cumulative production to 1980 is estimated at about 0.7 billion barrels, so remaining reserves as of 1980 are estimated at about 0.7 billion barrels. Estimates on northern Alberta gas based on methods similar to those used for oil are shown in Table V-12.(19) Total estimated gas reserves to be found by 1980 are estimated to be almost 8.75 trillion cubic feet, of which almost 6 trillion cubic feet will remain after allowing for cumulative production by then of 2.78 billion cubic feet. In both cases, recoverable reserves are estimated at 17 per cent of Alberta's total reserves in 1980, compared with 4.3 per cent of the oil reserves and 7 per cent of the gas reserves at the end of 1956.

These estimates are, of course, highly speculative as there is no way of knowing whether or not oil and gas will be found at the rate and average productivity per acre assumed, but in view of the continuing success in drilling activities in northwestern Alberta, there is good reason to believe that the estimates are conservative, although results obtained during the next decade will determine the scale of activity by 1980.

Although just outside the area, it would be well to mention the tremendous reserves potentially available from the Athabasca tar sands located in northeastern

TABLE V-11. ESTIMATED PROVEN RECOVERABLE RESERVES AND PRODUCTION OF NORTHERN ALBERTA OIL[a, b]

Volumes in Thousands of Barrels

Year	Year-End Remaining Recoverable Reserves	Annual Production	Cumulative Production	Virgin Recoverable Reserves	Life-Index[c] Years	Cumulative Wildcat Wells Drilled	Average Discovery per Wildcat Well Drilled
1949	342	6	6	348	57.0	41	8
1950	518	34	40	558	15.2	70	8
1951	554	20	60	614	27.7	120	5
1952	15,650	24	84	15,734	652.0	178	88
1953	115,261	59	143	115,404	1,953.5	212	544
1954	116,976	163	306	117,282	717.6	240	489
1955	121,352	925	1,231	122,583	131.2	265	463
1956	122,804	2,566	3,797	126,601	47.9	331	382
1958	196,200	6,600	13,800	210,000	29.7	525	400
1960	279,700	8,800	30,300	310,000	31.8	775	400
1965	451,700	19,000	108,300	560,000	23.8	1,400	400
1970	593,100	33,600	246,900	840,000	17.7	2,100	400
1975	668,100	46,000	451,900	1,120,000	14.5	2,800	400
1980	671,100	62,000	728,900	1,400,000	10.8	3,500	400

(a) Source: Report of the Royal Commission on the Development of Northern Alberta, Edmonton, Canada (March, 1958).
(b) Includes condensate but not natural gas liquids.
(c) Ratio of "Year-End Remaining Recoverable Reserves" to "Annual Production".

TABLE V-12. ESTIMATED MARKETABLE RESERVES AND MARKETED PRODUCTION OF NORTHERN ALBERTA GAS[(a)]

Volumes in Billions of Cubic Feet

Year	Year-End Remaining Marketable Reserves	Anual Marketed Production	Cumulative Marketed Production	Virgin Marketable Reserves	Life-Index[(b)] Years	Cumulative Wildcat Wells Drilled	Average Discovery per Wildcat Well Drilled
1951	592.5	0.268	0.268	592.8	2,211	120	4.94
1952	787.6	0.406	0.674	788.3	1,940	178	4.43
1953	1,118.9	0.536	1.210	1,120.1	2,088	212	5.28
1954	1,222.6	0.989	2.199	1,244.8	1,236	240	5.19
1955	1,250.5	1.470	3.669	1,254.2	851	265	4.74
1956	1,348.9	1.899	5.568	1,354.5	710	331	4.10
1958	2,029.0	59.2	71.0	2,100.0	34	525	4.00
1960	2,648.3	60.7	191.7	2,840.0	44	775	3.70
1965	4,184.0	88.0	576.0	4,760.0	48	1,400	3.40
1970	5,399.0	117.0	1,111.0	6,510.0	46	2,100	3.10
1975	6,024.0	161.0	1,816.0	7,840.0	38	2,800	2.80
1980	5,971.0	213.0	2,779.0	8,750.0	28	3,500	2.50

(a) Source: Report of the Royal Commission on the Development of Northern Alberta, Edmonton, Canada (March, 1958).
(b) Ratio of "Year-End Remaining Marketable Reserves" to "Annual Marketed Production".

Alberta. These reserves have been estimated at from 200 billion to 300 billion barrels, if economic means can be found for their recovery and processing. Cities Service Company, in conjunction with Richfield Oil Corporation, Imperial Oil Company, and Royalite Oil Company, is presently operating a $3.5 million pilot plant to study the economics of oil recovery from tar sands.(20) Richfield Oil Corporation has also proposed that the Atomic Energy Commission conduct an experiment using an underground atomic blast, with Richfield paying the costs.(21) The Great Canadian Oil Sands Company has also applied for a permit to construct a 30,000-barrel-per day plant costing in excess of $100 million. A hearing by the Oil and Gas Conservation Board was scheduled for mid-August, 1960, to consider this application, extension of the Cities Service development project, and a proposal of Pan American Petroleum Company to conduct an experiment on in-situ combustion.(22) Development of these tar sands would compete with oil from comparatively nearby wells in Alberta and British Columbia in the future.

British Columbia. Developments in northeastern British Columbia have been rapid during the past 5 years. The presence of gas had been known for many years, but it was not until Pacific Petroleum, Ltd., in 1952, drilled a well in what is now the Ft. St. Johns field that the province had its first commercial gas and oil. This discovery has been followed by finds of numerous other gas and several oil fields in the Peace River area. These reserves and the markets available in the Vancouver area and the U. S. Northwest led to the building of a 30-inch gas transmission line in 1957 to Vancouver and the U. S. border.(23) With an established market outlet for natural gas, petroleum companies have continued to explore northward, using the Alaska Highway as the traffic artery. In 1959, gas was discovered in the Ft. Nelson area, with one potentially important discovery (Celibeta) being located just over the line in the Northwest Territories. Discoveries of gas in this northern region at Kotcho Lake, Petitot River, Clark Lake, Celibeta, Ft. Nelson, and elsewhere assure tremendous new reserves.(24) Plans have been announced recently to build a 250-mile pipeline system linking this new reserve with established facilities. The new 30-inch line will run from Ft. Nelson to Taylor, British Columbia. Estimated cost, including facilities and additional wells, is estimated to exceed $100 million. Transmission capacity of the line will be about 650 million cubic feet per day and will raise total transmission capacity of the system to well over 1 billion cubic feet per day.(25) Development of the Beatton River, Milligan Creek, and Boundary Lake oil fields, north and east of Ft. St. John, has led to the authorization for a 130-mile, $5 million oil pipeline to connect this area with the small refineries at Taylor Flats and Dawson Creek.(26)

From the start of oil exploration in British Columbia to December, 1959, 473 wells have been drilled at a cost of about $145 million. During the 1959-1960 winter season, it is expected that more than 80 wells will be drilled at a cost of more than $40 million.(27) At the end of May, 1960, there were 82 oil wells and 208 gas wells in British Columbia capable of being operated.(28) It might be added that the gas produced in the Ft. St. John's area contains large quantities of hydrogen sulfide and condensate, so sulfur removal and natural gasoline plants are required for the separation. Sulfur production in 1959 dropped to 53,693 tons from 62,604 tons in 1958. Condensate production amounted to 513,000 barrels, of which 207,000 was separated as butane and 97,000 as propane.(29)

Development of the petroleum industry in British Columbia is still in its early stages, but the future looks immensely promising. Expenditures by the petroleum and natural-gas industry for land acquisition and rental, geological, geophysical, and drilling activities from 1950 through 1957 were reported as follows:(30)

1950 -	$ 1,001,000	1954 -	$11,554,000
1951 -	2,382,000	1955 -	10,592,000
1952 -	4,710,000	1956 -	16,861,000
1953 -	11,396,000	1957 -	19,988,000

Gross sales of gas and oil from 1956 through 1959 were as follows:(31)

	Gas	Oil
1956	$ 20,000	$ 229,321
1957	367,000	763,721
1958	3,915,239	1,008,366
1959	4,558,023	1,575,519

In 1958, it was estimated that direct expenditures arising out of the initial opening of the natural-gas fields in northern Alberta and British Columbia, and construction of the West Coast Transmission Company's natural-gas line were in the order of $770 million, that Crown revenues from natural gas and land rentals would exceed $80 million during the next 20 years, and that Canada would receive more than $500 million from U. S. customers for purchase of gas already committed.(32)* The same author pointed out the vital importance of the Alaska Highway to those developments:

> "For example, if it hadn't been for the Alaska Highway the development of this huge area would have been retarded for years. Without this highway, we would have found it almost impossible to move our drilling rigs; without the highway, I seriously doubt if today's major gas fields would have been discovered yet, and without the highway, the pipeline might never have been built."(32)

A recent announcement points out that provision has been made in the Canadian 1960-1961 budget to survey a route for an improved road from Ft. Nelson north to the Northwest Territories boundary to aid oil companies in the task of developing resources of the area.(33)

Yukon and Northwest Territories. During 1959, Western Minerals, Ltd., announced the discovery of oil and gas shows in a well drilled on the Eagle Plain, north of the Peel River in Yukon Territory. This was the first discovery in Yukon Territory. The first discovery in the Northwest Territories since finding the Norman Wells field was at Celibeta, just north of British Columbia.

*In view of the prolific discoveries made since 1958 in British Columbia, the Canadian Petroleum Association is of the opinion that these figures are unrealistically low.(11)

Activities in the Mackenzie River area have been reported. Scurry-Rainbow is drilling 18 miles west of the Mackenzie, north of Ft. Good Hope, within the Arctic Circle.[34] Richfield Oil Company and associates are also reported to have located a drilling site on the Mackenzie River, 85 miles northwest of Ft. Good Hope, 175 miles south of the Arctic Ocean, and 45 miles north of the Arctic Circle.[35]

Western Minerals is continuing work on its discovery well in Yukon Territory. Also, last winter the White Pass & Yukon Railroad built a winter road north from Keno Hill, Yukon Territory, 381 miles, and moved equipment for Amerada, The Ohio Oil Company, and Hudson's Bay Oil & Gas Company to their joint holdings of several million acres in the Eagle Plain, Ogilvie Basin in northern Yukon and Peel Plateau in the Northwest Territories. An account of this unique freighting operation has been given by the White Pass & Yukon Railroad Company.[36] The Canadian Government is planning an access road north from near Dawson, Yukon Territory, to Ft. MacPherson that will provide entry to this same general area.

An initial well, drilled by Amerada, et al., on their Eagle Plain location to about 7000 feet, has been unproductive and tentative plans call for discontinuing operations at this time and dismantling and removal of the rig from this area.[37]

Development in the Far North can be expected to progress slowly over the next decade, barring a major discovery, with various interested companies gaining a better knowledge of the region and engaging in sufficient exploration activities to fulfill the requirements of their exploration permits. Results of this activity, coupled with the status of the world oil picture in 1970, will determine the level of activity that may be reached by 1980.

Present Status of Oil and Gas Developments

The Canadian oil industry, particularly in the area included in this study, is still in the early stages of its development as can be noted from the preceding discussion. Its growth rate is somewhat inhibited because of the present state of oversupply of oil in world markets. During 1959, however, Canadian oil production increased 11.5 per cent over 1958 to 506,000 barrels per day, and gas production increased 29 per cent to 1.3 billion cubic feet per day.[38] Canadian consumption of oil was 829,000 barrels per day, reflecting the impact of imports to meet demands of eastern Canadian population centers. The Royal Commission has set a target for Canadian production of 700,000 barrels per day by the end of 1960, which will call for an estimated increase in Canadian demand of 59,000 barrels per day, and new exports of 80,000 barrels per day.[39] Canadian proved reserves of liquid hydrocarbon were estimated at almost 4 billion barrels, of which almost 3 billion barrels are in Alberta, and reserves of natural gas amounted to 26.6 trillion cubic feet, of which 23.3 trillion cubic feet are in Alberta.[40] The short-range goals of the Borden Commission for 1960 will not be met, however, as production will probably be in the neighborhood of only 550,000 barrels per day by the end of 1960.

Geophysical activities were also down appreciably due to the present depressed world oil picture, but exploration and development drilling activities held up well. Table V-13 shows various statistics on these activities for 1958 and 1959; Alaska has been included for comparison. It is impossible to judge what the Canadian Government's reaction will be to the low rate of production of Canadian oil relative to its potential

TABLE V-13. EXPLORATION STATISTICS, NORTHWESTERN CANADA AND ALASKA, 1958-1959[a]

	Alberta		British Columbia		Yukon and Northwest Territories		Alaska	
	1958	1959	1958	1959	1958	1959	1958	1959
Rigs Operating at Year End								
Exploratory	59	59	12	14	--	2	3	3
Develop	100	111	2	19	--	--	2	2
Exploratory Drilling								
Wells	519	549	48	66	9	8	3	8
Footage	2,799,581	3,008,731	263,051	373,627	36,493	25,322		
Development Drilling								
Wells	950	996	27	49			1	8
Geophysical Activity								
Seismic party months	663	529	101	107	24	24	53	92
Gravity party months	13	5		2	2	8		7.5
Surface Mapping, two-man party months	96	63	75	150	125	173	115	129

(a) Sources: Bulletins of the American Association of Petroleum Geologists (June, 1959 and 1960).
U. S. Bureau of Mines Bulletin, Department of Natural Resources, Division of Mines and Minerals, State of Alaska.

capability, particularly when the imbalance in the ratio of exports to imports of oil is considered. Quotas on imports or higher tariffs must certainly be considered as possibilities to encourage a greater consumption of Canadian oil within Canada.

Present and Potential Markets to 1980

Petroleum

The American petroleum industry has just completed its first century of operations. To those associated with the industry, it must seem as if there has been a continual series of dire predictions that the industry was either running out of oil or drowning in it. The present phase of the cycle is the latter. Since 1948, when serious concern was expressed in many quarters regarding the capabilities of the industry to meet the ever-increasing demands, the U. S. has increased its domestic proved reserves of liquid hydrocarbons from 26.8 billion barrels, December 31, 1948, to 38.2 billion barrels, December 31, 1959, while producing 18.5 billion barrels.(41)

In spite of this record of growth and achievement, world reserves of crude oil have increased at a much faster rate. Figure V-13 shows both this rate of growth for selected years from 1944 to 1959, and the changing relationship of North American reserves to the balance of the world. Whereas the U. S. had almost 40 per cent of the world's known proven crude oil reserves as of January 1, 1944, it had only 11 per cent on January 1, 1959. Development of the tremendous oil fields in the Middle East and the continuing string of discoveries there, in North Africa, and elsewhere have relegated U. S. and total North American reserves to a progressively lessening fraction of the world's total. More importantly, the degree of maturity of the U. S. oil industry relative to that in the Middle East, Africa, South America, and Russia makes it unlikely that future discoveries in the 48 southern states will reverse this trend.

Northwestern Canada and Alaska offer by far the best chance for long-range development of desirable continental reserves. On a broad geologic basis, potential reserves of up to 10 billion barrels have been postulated for Yukon Territory and Northwest Territories and up to 25 billion barrels for the Arctic Islands. A potential of 5 to 10 billion barrels can be postulated for Alaska, using similar basic assumptions. In addition to these possible reserves, there is the tremendous known reserve (up to 300 billion barrels of oil) in the Athabasca tar sands. In Colorado and Utah there are also the tremendous oil-shale reserves containing hundreds of billions of barrels of potential oil.

World Demand. World demand for petroleum has been increasing at a rapid rate but not nearly so fast as the increase in reserves. Figure V-14 shows this growth in demand and crude-oil production needed to meet the demand for 1950 to 1958. These requirements have been projected to 1980 in order to provide some basis for discussion of the order of magnitude that may develop. Assuming a continuing growth in the U. S. economy at a rate of about 3 per cent per year, its requirements for liquid fuels are expected to increase at about the same rate. This would mean that the U. S. may be consuming between 5.5 and 6.5 billion barrels of liquid fuels by 1980; Canadian needs may be expected to expand at a somewhat faster rate indicating a possible need of 0.75 billion barrels, or higher, by 1980.

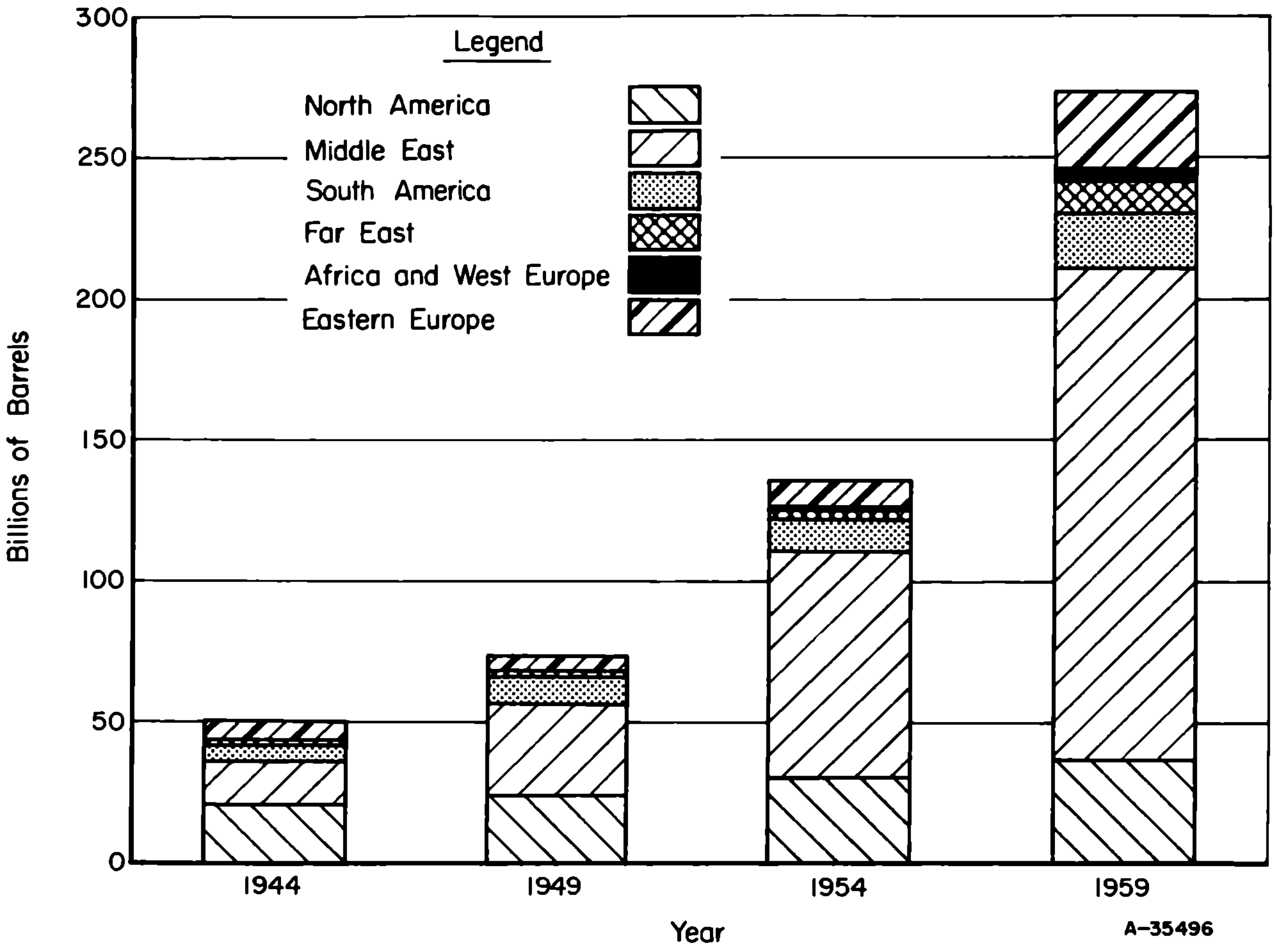

FIGURE V-13. ESTIMATED WORLD CRUDE-OIL RESERVES, SELECTED YEARS, 1944-1959

Source: Petroleum Facts and Figures, Contennial Edition, American Petroleum Institute (1959).

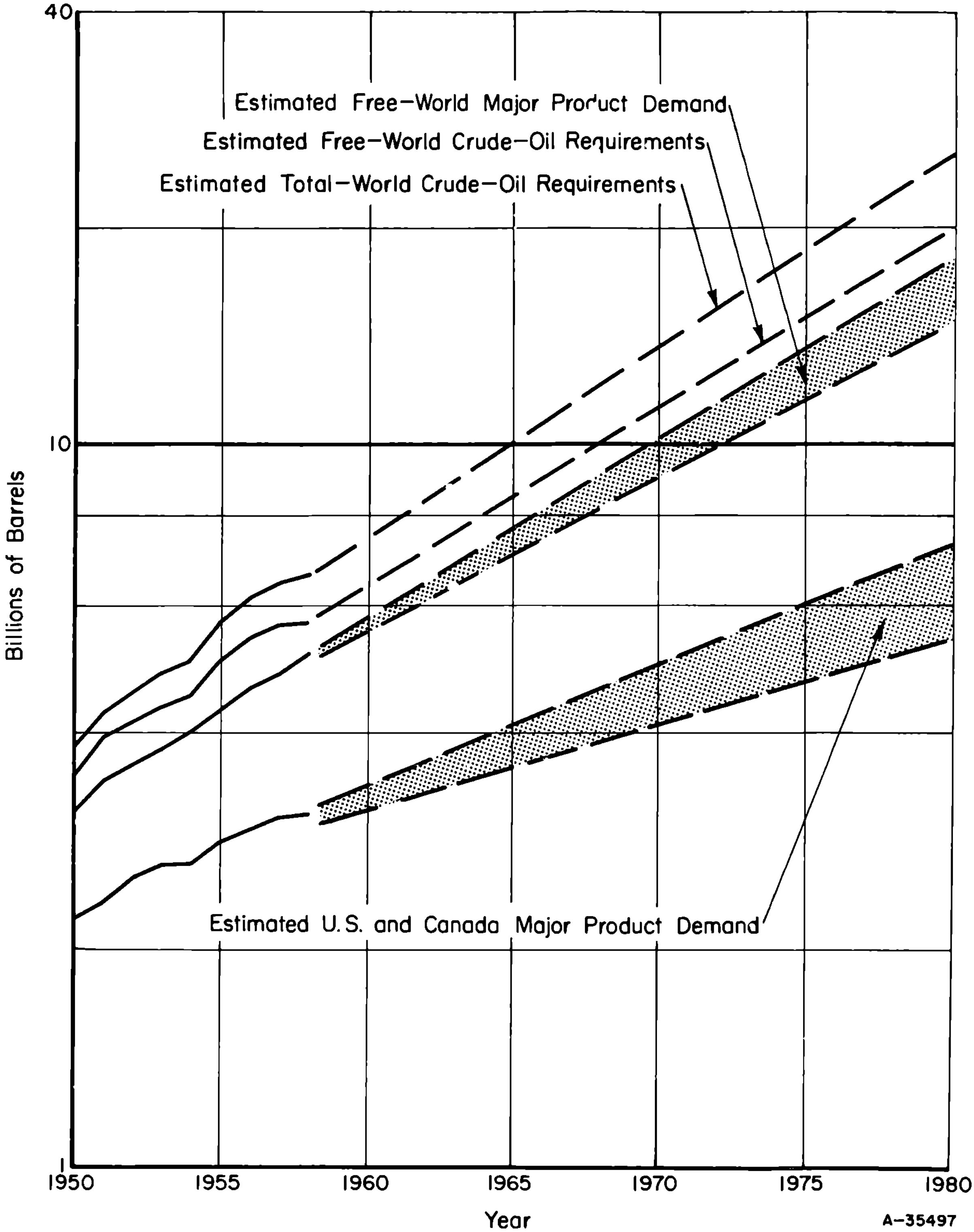

FIGURE V-14. WORLD CRUDE-OIL REQUIREMENTS AND ESTIMATED FREE-WORLD DEMAND, 1950 TO 1958, AND PROJECTIONS TO 1980

Sources: Petroleum Facts and Figures, Centennial Edition (1959).
U. S. Bureau of Mines.

Demand for petroleum products in the balance of the Free World has been increasing at a much faster rate than in the U. S. and, in view of the present low per capita consumption rates relative to those in the U. S. and Canada, wide variations can occur in their needs over the next 20 years, depending on the rate of economic growth achieved in various major countries during that time period. Excluding the U. S. and Canada, projected needs for the Free World by 1980 are estimated to be in the range of 9 billion to 12 billion barrels of crude oil equivalent, or 3 to 4 times present consumption rates.

Assuming that these growth rates are reasonable and will be achieved, crude-oil requirements over this period will amount to about 250 billion barrels, slightly less than present known Free-World reserves. Crude-oil reserves needed to support a virile industry in 1980 should be a minimum of 250 billion barrels, and virtually all of this must come from the discovery of new reserves, extension of presently known reserves, and advancements in the technology of the recovery of liquid hydrocarbons. This is a formidable objective, but one that should be attainable on a world-wide basis, provided satisfactory economic and political environments can be maintained.

It is important to note that U. S. and Canadian requirements between now and 1980 could amount to 90 billion barrels of crude oil. Assuming that a minimum of 80 per cent of these requirements is desired from continental sources, there is need for a continually growing search for economically recoverable supplies. Based on this assumption, economic sources of oil amounting to a reserve in the order of 100 billion barrels must be found by 1980. Northwest North America will be one of the major areas of this search during the next 20 years. Efforts in the next 5 to 10 years will be centered on exploration and in the succeeding 10 years on the development of those regions in which commercial quantities of oil have been located.

The exact areas and extent to which oil will be found can be little more than pure speculation on the basis of present knowledge. It is certain, however, that billions of dollars will be expended in this search.

The growth of world oil reserves at a rate much faster than growth in world demand has created some grave international problems with regard to allocation of production among the potential suppliers of crude oil. The fact that the U. S., as consumer of approximately half of the Free World's demand, could meet its present needs from domestic sources although it has only about 11 per cent of the proved reserves, demonstrates the immensity of the present dilemma. From a security standpoint, maintenance of adequate continental reserves and a strong domestic industry is of the highest priority. From the standpoint of the owners of oil reserves, income from sale of present known supplies is necessary to supply the capital and incentives for active efforts to find new reserves to meet expanding demands. From the standpoint of major producing states, the income obtained from oil production and the capital that can be utilized by the oil industry to expand its activities within the state are extremely helpful — if not vital — to the state's economic well being.

On the other side of the scale lie the pressures of foreign nations to find increased markets for their available crude oil which can be produced at costs substantially lower than the costs of finding new supplies in the U. S. The political and economic instability and immaturity of many of these foreign producing nations make this problem even more acute. Another factor is the concern of some regarding the depletion of an irreplaceable resource at a rate greater than absolutely necessary.

In the past, the large international oil companies have handled the vast bulk of the refining and distribution of the world's oil, so available refined supplies were closely related to estimates of markets made by the various individual companies. In the last few years, however, pressures by consuming nations to establish their own refining operations in order to improve their import position and to permit alternative selection of crude-oil sources, and equal pressures by producing nations to build refineries within their own boundaries in order to secure additional capital investment, employment, and income have resulted in world-wide refining capacities substantially greater than demand for petroleum products. Within the U. S., the intense competition among the various companies has also resulted in refining capacities considerably greater than present domestic demand. In the absence of international agreements, this condition of instability may be expected to continue until the supply-demand balance becomes more nearly equalized. This may require several years. During the interim period, development of new Canadian supplies will be restricted to some degree by limited markets for their oil, present demand for Canadian crude oil being only about one-half of the productive capacity for maximum economic recovery. The Borden Commission, in its recent review of energy, has recognized this problem in its evaluation of the demand for Canadian oil during the next several years, but unless actual demand increases appreciably, restrictions on imports of crude oil to Canada may be forthcoming to bring their domestic demand and supply balances much closer.

West Coast Markets. Historically, California supplied all of the indigenous production within the U. S. West Coast area. Production, however, has been unable to keep up with burgeoning West Coast demand during the past several years. In view of the present maturity of the productive areas in California, it is doubtful that future production rates can be expanded materially beyond 1 million barrels per day even though considerable success is obtained in offshore drilling in the area. Demands for petroleum products on the West Coast, however, are continuing to increase at a rate substantially greater than the average for the U. S. Chase Manhattan Bank, in a review in 1957 taking into account population growth rates and some replacement of fuel-oil needs by natural gas, estimated a growth in West Coast demand for oil amounting to 4.9 per cent per annum for a 10-year period, and a growth rate for natural gas at 6.4 per cent per annum.(42) This would indicate an annual demand of about 675 million barrels of liquid petroleum products by 1966 and a demand for natural gas amounting to about 2.2 trillion cubic feet by 1966.

Because of their geographic location, major West Coast markets are readily accessible to ocean transportation, so potential supplies can be received from anywhere in the world. Thus, transportation economics, added to the basic value of the oil at its source, in the absence of political or corporate restrictions, will determine the selection of sources.

The building of a Canadian crude-oil pipeline to the Pacific Northwest in 1955, and of a U. S. crude-oil line from the Paradox Basin to southern California in 1958, have also opened up the area to other continental sources. A products line also supplies light oils from the Southwest to California. Alaskan oil, should it be found in substantial quantities, will also find its major market possibilities in the West Coast area. In view of the growth, both in population and industry, appreciably greater than the national average that may be expected in the West Coast area over the next 20 years, substantial expansion in needs for nonindigenous supplies of petroleum is self-evident. Assuming that California will continue to be able to produce liquid hydrocarbons at present levels of about 1 million barrels per day over the next 20 years, which should be considered somewhat optimistic, needs for nonindigenous supplies, based on an annual growth rate in West Coast demand of 4 to 4.5 per cent, will amount to between 800,000 and 900,000 barrels per day by 1970. Presently, foreign imports are averaging about 250,000 barrels per day, and domestic products shipped into the area about 25,000 barrels per day. Thus, about 200 million barrels annually of additional supplies from all sources may be needed by 1970. At the same rate of increase, nonindigenous supplies of between 1.7 million and 1.9 million barrels per day may be required by 1980, or between 300 and 400 million barrels annually of additional supplies over projected 1970 requirements.

Table V-14 and Figure V-15 show the potential growth of markets for Alaskan and western Canadian crude oils in the California and other Pacific area regions.

Expanded needs for the Canadian West Coast area on the basis of a 4 to 45 per cent increase per year may be expected to be in the range of 95,000 to 110,000 barrels per day, or between 35 million and 41 million barrels annually by 1980.

Alaska and Hawaii. Demand in Alaska may increase from its present 15,000 barrels per day (5.5 million barrels annually) to about 25,000 barrels per day (9 million barrels annually) by 1970, by which time a refinery might be in operation, if sufficient indigenous supplies have been found and can be made available. During the succeeding 10 years, needs should continue to expand at an equal or faster rate, indicating a possible demand of 45,000 barrels per day (15 million barrels annually) by 1980. Another potential market area for Alaskan oil would be Hawaii, which has no indigenous supplies. A refinery has recently been constructed to meet the Islands' needs of more than 30,000 barrels per day (11 million barrels annually). These needs will increase over the next several years, providing a relatively small, but growing, market for domestic crude oil. Assuming a 4 per cent annual increase, the demand in 1970 would amount to about 45,000 barrels per day, increasing to 65,000 barrels per day or so by 1980 (24 million barrels annually).

Japan. Japan might be another good potential market for Alaskan and Canadian oil. Japan's indigenous production has been negligible – its supplies being obtained principally from Indonesia and the Middle East. Recently, oil has been found in offshore areas of Japan, but production rates are still less than 10,000 barrels per day. Also, Japanese interests have made an important discovery in the offshore area of Saudi Arabia. Present consumption rates of about 300,000 barrels per day are many times presently available supplies controlled by Japan, so opportunities exist for additional crude oil that can be delivered at competitive prices. Crude-oil refining capacity in Japan was rated at 553,200 barrels per day in 1959[43], reflecting the present controls on purchase and use of foreign oils. Japan is planning to increase its use of petroleum products markedly over the next several years. Data from its Economics Planning Board indicate a doubling of demand between 1956 and 1962, and five times its 1956 demand by 1975. Work is underway to enlarge and modernize its refining capacity and to develop a sizable petrochemical industry.[44]

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TABLE V-14. HISTORICAL AND POTENTIAL LIQUID-PETROLEUM SUPPLY-DEMAND RELATIONSHIPS IN SELECTED AREAS[a]

Millions of Barrels

						1965			1970				1980		
	1950	1955	1958	1960		3%	4%	4.5%	3%	4%	4.5%		3%	4%	4.5%
U. S. West Coast Demand	321	396	411	445 (est.)		516	542	554	598	659	691		804	975	1073
Less:															
Indigenous Production of Crude Oil	328	355	314	345 (by diff.)		365	365	365	365	365	365		365	365	365
Estimated 1960 Supply of Crude Oil and Refined Products From Other Sources				100		100	100	100	100	100	100		100	100	100
Balance Needed From Other Sources				--		51	77	90	133	195	226		339	512	608
British Columbia - Consumption	16	24		29			35	36		43	45			64	70
Alaska - Consumption				5.5			6	7		8	9			12	13
Hawaii - Consumption				11			13	14		16	17			24	27
Subtotal - Additional Needs Over 1960				--			85	102		216	254			566	684
Japan - Demand	15	69	118		157 (1962)							413 (1975)			
Crude-Oil Production			3		3							3			
Imports of Crude Oil			104		104							104			
Imports of Refined Products			21		21							21			
Subtotal - Additional Japanese Needs Over 1958 Supply From All Sources			--		29							285			

(a) Sources: American Petroleum Institute, U. S. Bureau of Mines, U. S. Department of Commerce, World Petroleum Report.

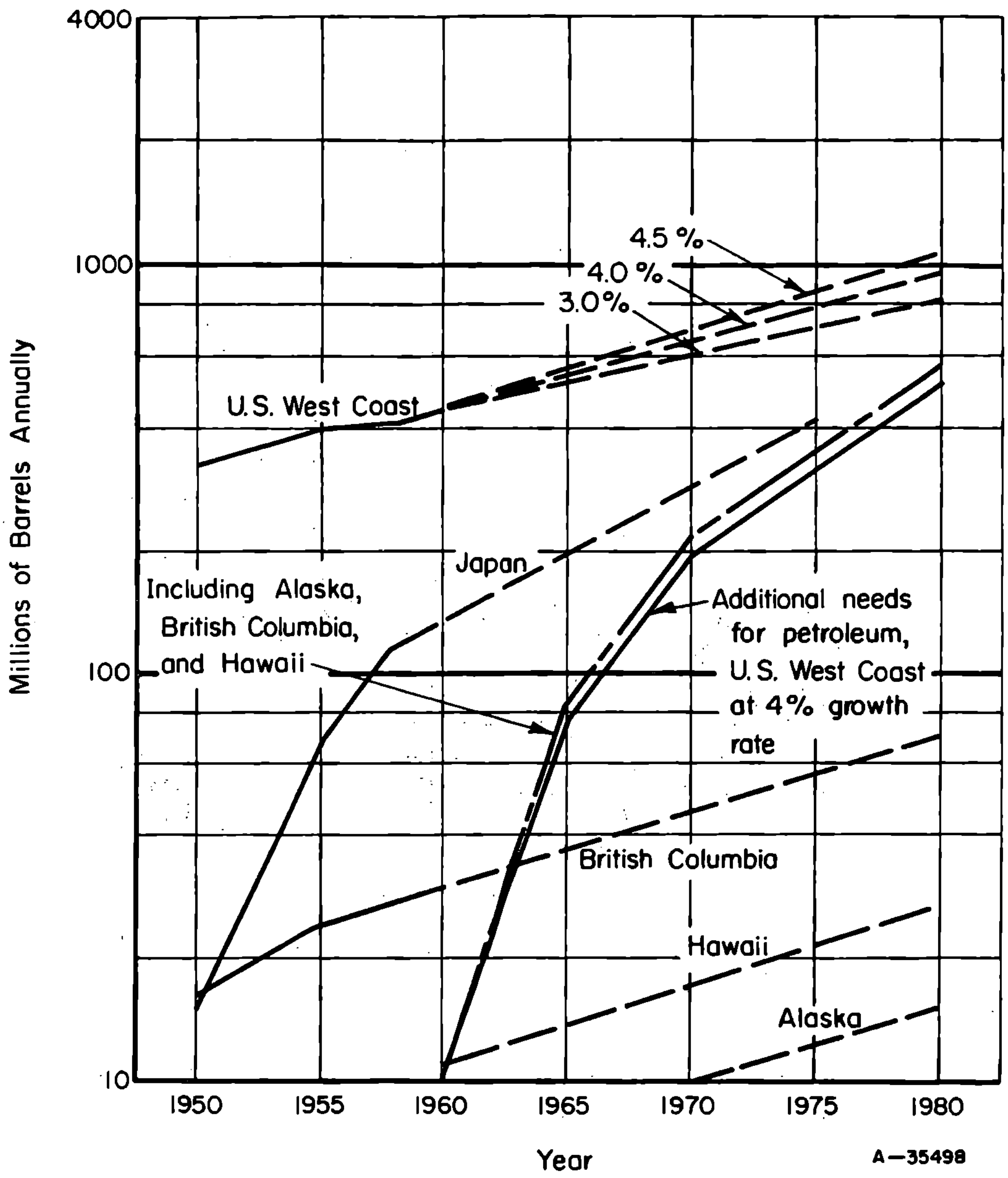

FIGURE V-15. POTENTIAL GROWTH IN DEMAND FOR LIQUID PETROLEUM, IN SELECTED AREAS

Sources: American Petroleum Institute.
U. S. Bureau of Mines.
U. S. Department of Commerce.
World Petroleum Report, Vol. VI, Morse Palmer Publishing Company, New York (February 15, 1960).

Natural Gas

West Coast needs for natural gas continue to expand at a rapid rate. Increased demands in that area should absorb available Canadian natural gas as additional supplies are released by Canada and facilities for its movement are constructed. West Coast Transmission Corporation has recently announced plans to increase its capacities for movement of gas to the Pacific Northwest from 650 million to 1 billion cubic feet per day. Should undue restrictions be placed on quantities of gas that may be exported to the U. S., rising prices for the available gas might permit the economic liquefaction and movement of natural gas from Alaska to West Coast terminals within 20 years.

Japan is a more immediate possibility for the development of economic markets for liquefied natural gas. It is known that Conch (Constock) International Methane, Ltd., has been planning to initiate service to Japan within 2 years.(45) Also, the Union and Ohio Oil Companies have been actively considering the possibility of shipping liquefied natural gas to Japan from their holdings in Alaska, provided suitable arrangements can be made with Japanese interests and authorities.(37) Conceivably, this could result in the annual liquefaction of tens of billions of cubic feet of natural gas within the next 10 years for shipment from the Kenai to Japan. Because of its much closer location, Alaska is the most logical source for such desired imports of natural gas.

Potential Impact on the Area's Economy

The finding and development of oil and gas reserves in both northwestern Canada and Alaska during the next 20 years must be considered to be primarily for the supply of markets outside of the region. Presently available supplies of both oil and gas in northwestern Canada already far exceed the needs of that region. Gas reserves in the Kenai may be inferred to be several times the amount required to serve economically justifiable markets over the next 20 years. Crude-oil productive capacity on the Kenai is approaching the equivalent amount of petroleum products needed to satisfy the civilian requirements in the Rail belt area, and inferred reserves in the area should be sufficiently large to take care of normal military requirements as well, if desired.

Presently, military installations in the Fairbanks area are serviced by a 626-mile, 8-inch pipeline from the P. O. L. dock and terminal installation at Haines to the Ladd-Eielson Air Force Bases.(46) Capacity of the line is 12,000 barrels per day, and annual movement of light distillate oils in 1959 was about 200,000 tons. Provision is also made for backpumping through a 3-inch line from Haines Junction to a Canadian military base at Whitehorse, Yukon Territory. This 3-inch line was constructed as part of the Canol project to supply distillates from the refinery at Whitehorse to Fairbanks. The 3-inch line from Haines Junction to Fairbanks is still in place but inoperable. Military installations near Anchorage are serviced by tankers to terminals in that area.

Unfortunately, neither the volume of petroleum products required nor the "product mix" is suited to the design of a conventional, modern, economic-size petroleum refinery in Alaska.

To meet the product demands of the Rail belt area in full would require a refinery having crude-oil refining capacity considerably in excess of the area's needs, unless special equipment for reconversion of products were added. In view of the small size of a refinery designed to meet present demand, it is doubtful if the cost of these special units could be economically justified. On the other hand, a conventional refinery capable of supplying the area's requirements would have to find markets for a substantial portion of its refined products in noncontiguous locations. Another alternative would be a much smaller refinery designed to supply only a portion of the regional demand. In such case, a substantial portion of the requirements would still have to be supplied from outside sources, so a decision to build such a refinery would depend on careful appraisal of the over-all economics or the development of a special situation. On the other hand, a continuing growth in Alaska's economy should lead to economic justification for a small refinery – 10,000 barrels per day or so – within the next decade.

Presently, the only refineries in the entire area under study are as follows:(47)

Location	Company	Type Refinery	Crude-Oil Capacity, bbl/day	Other Units
Norman Wells, NWT	Imperial Oil, Ltd.	Skimming	1,350	--
Grande Prairie, Alta.	North Star Oil, Ltd.	Skimming and cracking	2,500	Catalytic reformer and desulfurization
Dawson Creek, B.C.	X-L Refineries	Skimming and cracking	3,000	Catalytic reformer; Houdriformer and asphalt unit
Taylor Flats, B.C.[a]	Phillips, Pacific, Westcoast	Skimming and cracking	2,000	Alkylation unit

(a) Natural-gas processing plant. Daily capacity 300 million cubic feet producing 3,500 barrels per day of liquid by-products also located here.

Present needs in the region around Whitehorse are serviced by tanker shipments to Skagway and Haines, Alaska. Shipments from Skagway to Whitehorse are by the White Pass & Yukon Railroad or by a 4-inch pipeline built as part of the Canol project, depending on the products involved. Movements from Haines are by tank truck, including some heavy crude oil transported to a small asphalt plant at Haines Junction for asphalt production.

In view of the small internal market for petroleum products, it must be concluded that the primary economic benefits of oil development in the region under study would be to provide income to the state, territories, and provinces, and to provide job opportunities for individuals associated with the finding and production of crude oil and natural gas, and for individuals servicing the needs of the oil industry and its personnel. These benefits, however, will be appreciable. In view of the present formative stages of oil and gas development in the region under study, any estimates as to the scale of operations that might be involved 20 years hence can be little more than an educated guess. It is necessary for the purpose of this study, however, to attempt to evaluate the level of operations that might be involved by 1980. Based on known oil and gas developments and plausible extensions of these activities within the region, the following estimates have been made for <u>increases</u> in personnel and oil and gas production between 1959 and 1980:

	Annual Crude-Oil Production, million barrels	Annual Natural-Gas Production, billion cubic feet	Petroleum Industry Employees	Total Population Increase
Alaska	25	100	3,500	21,000
Northeastern British Columbia	50	400	5,000	30,000
Northwestern Alberta	55	153	3,500	21,000
Yukon Territory and Northwest Territories	Unknown	Unknown	Unknown	

Estimates for Alaska are based on plausible extensions of oil and gas activities in the southern Alaska region. Exploration activities are just getting underway in central and northern Alaska regions, so it will be several years before any idea as to their potential can be assessed. The Yukon and Northwest Territories are even more remote from possible markets for petroleum. Thus, discoveries of major oil or gas fields must be made before commercial production would be warranted. Barring such a discovery or a more urgent necessity for finding new continental supplies, it is reasonable to assume that most of the next 20 years will be largely spent in exploratory efforts and that production from those regions will be small.

The estimates for 1980 production of oil and gas for northwestern Alberta were made by the Royal Commission on the development of northern Alberta in its 1958 report, (19) and the above table shows the estimated increases over the 1958 estimated rates. Employees shown as associated with this estimated growth comprise only those directly concerned with developments within northern Alberta. It is believed that divisional and general offices of the oil companies having operations in Alberta would remain in Edmonton or Calgary, so any expansion in needs for personnel in those locations is not included. Consequently, personnel needs within the area are shown as smaller than those in Alaska and British Columbia for equivalent increases in production.

Proved reserves of oil and gas in British Columbia are still quite small relative to those of Alberta. However, sedimentary deposits in northeastern British Columbia are deeper than those in northwestern Alberta. This fact, coupled with the success in finding new major discoveries during the past 3 years, makes it reasonable to assume that British Columbia should be able to attain crude-oil production roughly equivalent to that in northwestern Alberta. It is believed that natural-gas production will be substantially greater, however, as Alberta has tremendous reserves in other areas of the province closer to markets that would be utilized at an earlier date.

There can be little doubt that potential gas supplies on the Kenai Peninsula are far in excess of the amounts that region can use during the next 20 years. This provides the basic opportunity for developments of major energy-consuming industries in the region, provided the needed raw materials are located in Alaska or can be transported there for most economical processing relative to their markets. Over the next several years, the economic possibilities for reduction of iron ore and the smelting of various nonferrous metals should be examined. Once those have become economical, further opportunities should develop for alloying and basic metals forming and fabrication.

Announcement was recently made by Permanente regarding installation of a cement plant in the general Anchorage area having an annual capacity of 500,000 barrels. Low-cost gas or coal are preferred fuels for cement manufacture, and as of September, 1960, it had not been announced whether coal or gas would be used to fuel the plant.

A careful examination of the market possibilities for a petrochemical plant using natural gas for making ammonia and its derivatives, methanol, or products based on acetylene should uncover economic opportunities during the next several years for sale of products in Japan, Hawaii, and on the West Coast. The establishment of petroleum refining operations is envisioned within the next 10 years. By-product gases from these operations might be used with LP-gases found in association with new oil discoveries to offer other possibilities for petrochemicals. Until such time as large-scale hydro-electric plants are built, natural gas might also be used to develop electric power, permitting rates for large-scale industrial use substantially below present costs. Natural gas can also be used directly to provide steam and heating for a variety of manufacturing operations that may be developed during the next 20 years. Field prices for natural gas in the Kenai have not been announced, but rates at least equivalent to those in the Southern states should be readily obtainable at the wellhead for desirable large-scale industrial use.

Mention might also be made of the large reserves of natural gas in the Gubik field in northern Alaska. Presently, civilian demand in the Fairbanks area is not large enough to justify a pipeline from the field to Fairbanks. Current economics might favor extension of a line from the Kenai to supply the Fairbanks area. At some long-range future date, the flow of the line might be reversed to supply Gubik gas for southern Alaska.

As mentioned previously, if much of the available gas from the Kenai area is to be used during the next 20 years, it will have to be liquefied and shipped to Japan and other major consuming areas. Should the economics of this type of movement be proved, and provided satisfactory arrangements can be made with the consumers, the liquefaction and shipment of 100 million cubic feet per day might be reached during the next 10 years. This rate might be doubled during the succeeding 10 years.

Employees for these potential oil- and gas-using and -processing plants are included in the estimates shown above; they would probably comprise less than 10 per cent of the numbers given for total industry employees. Value added by manufacture from these potential operations might amount to $10 million or more annually by 1980.

Transportation Needs

The use of roads, railroads, and airplanes by the exploration and production sections of the petroleum industry is primarily to provide a means of supplying the exploration and developmental activities being undertaken. In the U. S., less than 0.5 per cent of the crude-oil production is moved by rail and less than 6 per cent is moved by truck.(43) Use of roads or railroads for the distribution of petroleum products from the refinery is limited to relatively small, individual movements, largely to wholesale and retail distributors, and for supplying needs within a radius of a few hundred miles at most. Trucks account for 36 per cent of the total shipments of refined products and railroads for about 6 per cent.(43)

It was pointed out, in discussions with a number of oil companies, that the construction of roads as a means of encouraging oil exploration could not be economically justified in itself. Where other uses for a road system are indicated, the presence of a road in the exploration area would be helpful, but the decision to conduct exploration activities is not based on accessibility by road. Instead, primary decisions are based on geologic evaluations of the area, the availability of suitable blocks of land under acceptable economic conditions, and the petroleum laws and political climate involved. In many remote and foreign areas, airplanes are used to supply the entire operation, in many cases requiring the construction of suitable landing strips.

Once oil is discovered, however, a road to the area and access roads to the desired well locations are needed to bring in the volume of proper supplies and equipment needed for field development and for the construction of pipelines to move the oil or gas to terminal locations for use or transshipment. Tonnage involved per well varies widely depending on location of the well, its depth and formation conditions, equipment in use, and various other factors. An extensive investigation of the logistics of oil exploration in Alaska, made in a recent study, showed variations in tonnage requirements per well of from 1000 to 6000 tons or more.(11) Another paper covering exploratory operations near Yakutat included an estimate of 2500 tons of drilling supplies for a well in that area.(13)

Thus, as an example, a continuing exploratory and development program involving the drilling of 25 wells annually in a given region would require the movement of 50,000 to 100,000 tons or so of drilling supplies to the area annually. Substantial additional tonnages would be needed to house, equip, and feed the oil-field personnel and to provide storage and pipeline facilities for movement of the oil to terminals. In the absence of adequate roads, costs of 25 cents or more per ton-mile might be involved. On the other hand, with suitable roads, costs might be in the order of 5 to 10 cents per ton-mile. Therefore, an adequate road system would mean an annual saving (or reduction in cost) amounting to $10,000 to $20,000 or more per mile. Construction of a good gravel road may cost from $50,000 to $100,000 or more per mile, depending on the terrain and conditions involved, while annual maintenance might be in the range of $2000 to $3000 per mile. Thus, in areas where operations may be expected to continue for several years, industry support of a road might be justified when its construction can be shown to be primarily for its benefit. Whenever major new areas are found, a suitable road system to encourage their early optimum development would be necessary. Expenditures by the state or federal government for this purpose are quite proper, although in some instances industry assistance might be indicated.

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HYDROELECTRIC POWER

The water-power resources of Northwest North America represent one of the world's largest potentials for the development of hydroelectric power. The full potential of the Area is not yet known, but studies completed to date indicate a total potential capacity of some 27 million kw for Alaska and the area of northwestern Canada of interest for this study. Inclusion of numerous small potential hydroelectric sites of 2000 kw or less and revision of original estimates would be expected to add to this total.

Developed Hydroelectric Capacity

Alaska

Only a minute portion of the water-power potential of Alaska has been developed. As of January 1, 1958, a total of seven hydroelectric plants totaling 48,675-kw capacity were listed by the Federal Power Commission as being in service for electric-utility systems. The pattern of electric-power generation of all types in Alaska is shown in Table V-15. Hydroelectric generation represents slightly less than one-half of the total generating capacity operated by utilities, the remainder being almost evenly divided between steam and internal-combustion plants.

The largest hydroelectric plant in Alaska is the Eklutna plant near Anchorage with a capacity of 30,000 kw. This plant was constructed by the U. S. Bureau of Reclamation and placed in operation in 1955. Under contracts with the Interior Department, its output is taken by the city of Anchorage, the Chugach Electric Association, Inc. , and the Matanuska Valley Electric Association. Plans to increase the capacity of the Eklutna project by 2000 kw through construction of a higher earth dam and modification of other facilities have been announced, and a bill authorizing the work has been introduced in Congress.

TABLE V-15. TOTAL GENERATING CAPACITY IN ALASKA BY METHOD OF GENERATION, AS OF JANUARY 1, 1958[a]

Method of Generation	Installed Capacity, kw			
	Utility	Nonutility		Total
		Industry	Military	
Hydro	48,675	17,349	0	66,024
Steam	27,500	33,950	164,900	226,350
Internal combustion	26,500	8,223	64,900	99,623
Total	102,675	59,522	229,800	391,997

(a) Source: Federal Power Commission.

Table V-16 lists the principal hydroelectric plants in operation in Alaska. Of the total of 33 hydroelectric plants, 27 have capacities of 500 kw or less. Most of these are small plants serving operations of the fishing industry. With 66,024 kw of installed capacity, hydro represents slightly over 40 per cent of the total utility and industrial generating capacity.

TABLE V-16. HYDROELECTRIC POWER PLANTS IN ALASKA, AS OF JANUARY 1, 1958[a]

Plant	Installed Capacity, kw
Eklutna Power Plant, near Palmer	30,000
Alaska Juneau Gold Mining Co., Juneau	15,675[b]
Ketchikan Public Utilities, Ketchikan	11,800
Municipal Light and Power Co., Petersburg	2,400
Metlakatla Power and Light Co., Metlakatla	2,000
Alaska Electric Light and Power Co., Juneau	1,600
All others (27 in number) total	2,549
Total	66,024

(a) Source: Federal Power Commission.
(b) Only partially operable at present, with capability of delivering some 6,850 kw to the Juneau area.

The generating capacity at various military installations represents almost 60 per cent of the total available in Alaska. None of this is hydro power.

Prospects for increased hydro capacity are brightening, however. Construction of a 15,000-kw hydroelectric plant at Cooper Lake on the Kenai Peninsula by the Chugach Electric Association is nearing completion. A 6000-kw project is under construction at Blue Lake by the City of Sitka. A feasibility report by the Bureau of Reclamation has tentatively recommended construction of the Crater-Long Lakes Division of the Snettisham project. This 48,000-kw development would furnish power for a proposed newsprint mill near Juneau, as well as other power needs of the Juneau area. A number of other potential hydro-power developments have been studied by the Bureau of Reclamation and the U. S. Army Corps of Engineers. These are described briefly in subsequent sections.

Northwestern Canada

As in Alaska, only a token amount of the potential hydroelectric sites in northwestern Canada has been developed. Table V-17 summarizes the capacity developed in the area of interest for this study. Four installations represent the major part of the total capacity: (1) a 11,190-kw plant on the Klondike River operated by the Yukon Consolidated Gold Corporation, (2) a 4,475-kw plant on the Mayo River operated by the Northern Canada Power Commission, (3) a 3,730-kw plant on Falls Creek near Anyox operated by the Consolidated Mining and Smelting Company of Canada, Ltd. , and (4) a new 11,200-kw plant on the Yukon River near Whitehorse operated by the Northern Canada Power Commission.

TABLE V-17. DEVELOPED HYDROELECTRIC CAPACITY IN NORTHWESTERN CANADA[(a)]

Area	Installed Capacity, kw
Northern British Columbia	5,820
Northwestern Alberta	0
Yukon Territory	27,900
Northwest Territories (west of Mackenzie River)	0
Total Developed Capacity	33,720

(a) Source: "Water Powers of Canada", Water Resources Branch, Department of Northern Affairs and National Resources, Ottawa (1958).

Several multimillion-kilowatt hydroelectric developments in the area have been given serious consideration, notably the Yukon-Taku and the Peace River sites.

Undeveloped Hydroelectric Resources

Alaska

Table V-18 lists the major potential hydroelectric sites in Alaska as compiled by the Federal Power Commission in its May, 1960, report on "Alaska Power Market Survey". Potential sites of less than 10,000 kw of installed capacity are not listed, but are included in the "other" category to give the total capacity of over 18 million kw of installed capacity.

Figure V-16 shows the location of the potential water-power sites; the size of the circle indicates the order of magnitude of the potential power to be developed at each location. The number beside each circle corresponds to the listing in Table V-18. Detailed studies have been made of only a few of the potential water-power sites. For the most part, the capacities listed are preliminary estimates made by the Bureau of Reclamation and the Army Corps of Engineers over the last 12 years.

The term "installed capacity" represents the total capacities as shown by the name plates of the generating units in a station. Prime power is that available from a plant on a continuous basis under the most adverse hydraulic conditions contemplated. For most of the undeveloped sites listed in Table V-18 the installed capacity is about twice that for the prime power capacity, indicating a plant factor of about 50 per cent. For specific

TABLE V-18. POTENTIAL UNDEVELOPED HYDROELECTRIC SITES IN ALASKA(a)

10,000 Kw and Over, Installed Capacity

Name of Project or Site(b)	Estimated Potential, kw Installed Capacity	Estimated Potential, kw Prime Power
Southeastern Alaska(c)		
1. Davis River	42,000	21,000
2. Wilson Lake	12,700	6,350
3. Punchbowl Lakes	18,600	9,300
4. Granite Lakes	12,700	6,350
5. Tyee Lake	33,500	16,800
6. Harding River	29,000	14,600
7. Cascade Creek(d)	34,000	16,900
8. Scenery Creek(d)	18,000	18,300
9. Sweetheart Falls Creek	32,000	16,100
10. Tease Lake	13,700	6,850
11. Speel River (d)	72,000	36,000
12. Long Lake(d)	42,000	21,000
13. Crater Lake(d)	22,000	11,000
14. Dorothy Lake(d)	28,000	15,000
15. Carlson Creek	12,800	6,400
16. Antler Lake	12,500	6,200
17. Endicott River	19,500	9,700
18. Reynolds Creek	12,500	6,200
19. Beaver Falls Creek	11,000	5,500
20. Orchard Lake	12,000	6,000
21. Lake Grace(d)	22,000	11,000
22. Mirror, Ella and Manzanita Lakes(d)	29,600	14,500
23. Swan Lake(d)	15,000	7,630
24. Maksoutof River	34,000	17,000
25. Takatz Lake(d)	15,000	7,600
26. Brentwood Lakes	10,500	5,200
27. Hasselborg River	24,000	12,000
28. Thayer Lake	17,000	8,500
29. Lake Kathleen	12,000	6,000
Others	360,490	
Southeastern Alaska Total	1,030,090	
Cook Inlet and Tributaries(d)		
30. Stelter	66,000	33,000
31. Kasilof	24,000	12,000
32. Bradley Lake	46,000	23,000
33. Knik Glacier-Lake George	200,000	120,000
34. Caribou	48,000	24,000
35. Portage (Devil Canyon)	480,000	240,000
36. Watana	370,000	185,000
37. Denali (Vee)	460,000	230,000
38. Cache	42,000	21,000
39. Talkeetna	90,000	45,000
40. Shell	30,000	15,000
41. Hayes	30,000	15,000
42. Beluga	26,000	13,000
43. Crescent (City of Seward FPC License No. 2171)	10,500	9,500
Others	34,600	
Cook Inlet and Tributaries Total	1,957,100	
Copper River and Gulf Coast(d)		
44. Wood Canyon (FPC Prelim. Permit No. 2215 "Copper River")	1,710,000	1,280,000
45. Peninsula	650,000	490,000
46. Nizina	78,400	58,800
47. Kennicott	17,200	12,900
48. Tebay Lakes	61,400	30,700
49. Bremner	61,300	46,000
50. Tiekel	26,700	20,000
51. Tonsina Lake	20,000	10,000
52. Klutina Lake	54,000	40,500
53. Tasline Lake	74,700	56,000
54. Power	14,500	7,250
55. Keystone Canyon	31,000	15,500
56. Bear Lake	40,000	20,000
57. Resurrection	11,520	5,760
Others	13,000	
Copper River and Gulf Coast Total	2,863,720	
Tanana River Basin(d)		
58. Nenana	24,000	16,000
59. Jack	13,000	9,000
60. Carlo	25,000	25,000
61. Yanert	62,000	35,000
Tanana River Basin(d) (Continued)		
62. McKinley	63,000	33,000
63. Moody	20,000	13,000
64. Slagle (FPC Prelim. Permit No. 2227)	30,000	19,000
65. Kantishna	38,000	19,000
66. Teklanika (3 plants)	40,600	20,300
67. Totatlanika	15,800	7,900
68. Chena	10,200	5,100
69. Salcha	21,400	10,700
70. Cathedral Bluffs	108,000	65,000
71. Chisana	23,000	11,500
Others	8,500	
Tanana River Basin Total	502,500	
Southwestern Alaska(d)		
72. Terror Lake	18,800	9,400
73. Spiridon	23,000	11,500
74. O'Malley-Karluk-Frazier Lakes	34,000	17,200
75. Grecian River-Crescent Lake	40,000	30,000
76. Lachbuna Lake (was Ingersol Lake)	47,800	35,800
77. Lake Kontrashibuna	13,900	10,400
78. Tazimina Lakes	50,500	37,900
79. Kukaklek Lake	85,700	64,300
80. Kulik Lake-Nonvianuk Lake	10,800	5,400
81. Upnuk Lake	10,300	7,700
82. Chikuminuk Lake	51,700	38,800
83. Nuyakuk-Tikchik Lakes	93,600	70,200
84. Aguluwak River-Lake Aleknagik	42,300	31,700
85. Grant Lake	11,400	5,700
Others	9,100	
Southwestern Alaska Total	542,900	
Northwestern Alaska(d)		
86. Koyuk River	16,000	8,000
87. Fish River	14,000	7,000
88. Kukpuk River	22,700	11,350
89. Imuruk Basin	60,000	45,000
90. Kiwalik River	13,500	6,750
91. Kugruk River	14,050	7,025
92. Noatak River	370,000	278,000
Others	5,400	
Northwestern Alaska Total	515,650	
Yukon and Koskokwim River Basins (Exclusive of Tanana River Basin)(d)		
93. Kaltag	2,360,000	1,770,000
94. Rampart Canyon	4,690,000	3,520,000
95. Woodchopper Creek	2,710,000	2,030,000
96. Porcupine River near Campbell River	185,000	140,000
97. Nowitna Site	33,000	24,800
98. Melozitna River	50,000	37,000
99. Kanuti Site	515,000	385,000
100. Hughes	175,000	130,000
101. Crooked Creek	576,000	430,000
Yukon and Kuskokwim River Basins Total (Exclusive of Tanana River Basin)	11,294,000	

Summary	Number of Sites	Installed Capacity, kw
Southeastern Alaska	141	1,030,090
Cook Inlet and Tributaries	19	1,957,100
Copper River and Gulf Coast	17	2,863,720
Tanana River Basin	15	502,500
Southwestern Alaska	16	542,900
Northwestern Alaska	8	515,650
Yukon and Kuskokwim River Basins (Exclusive of Tanana River Basin)	9	11,294,000
Alaska Total	225	18,705,960

(a) Source: Alaska Power Market Survey, Federal Power Commission, Bureau of Power, San Francisco Regional Office, May, 1960.
(b) Numbers correspond with those given on the map of Alaska, Figure V-16.
(c) Unless noted, all projects or sites listed hereunder are from report "Water Powers – Southeast Alaska, 1947", by FPC and USFS.
(d) All projects or sites listed hereunder are from information furnished by U.S. Army District Engineer, Alaska; Anchorage, Alaska.

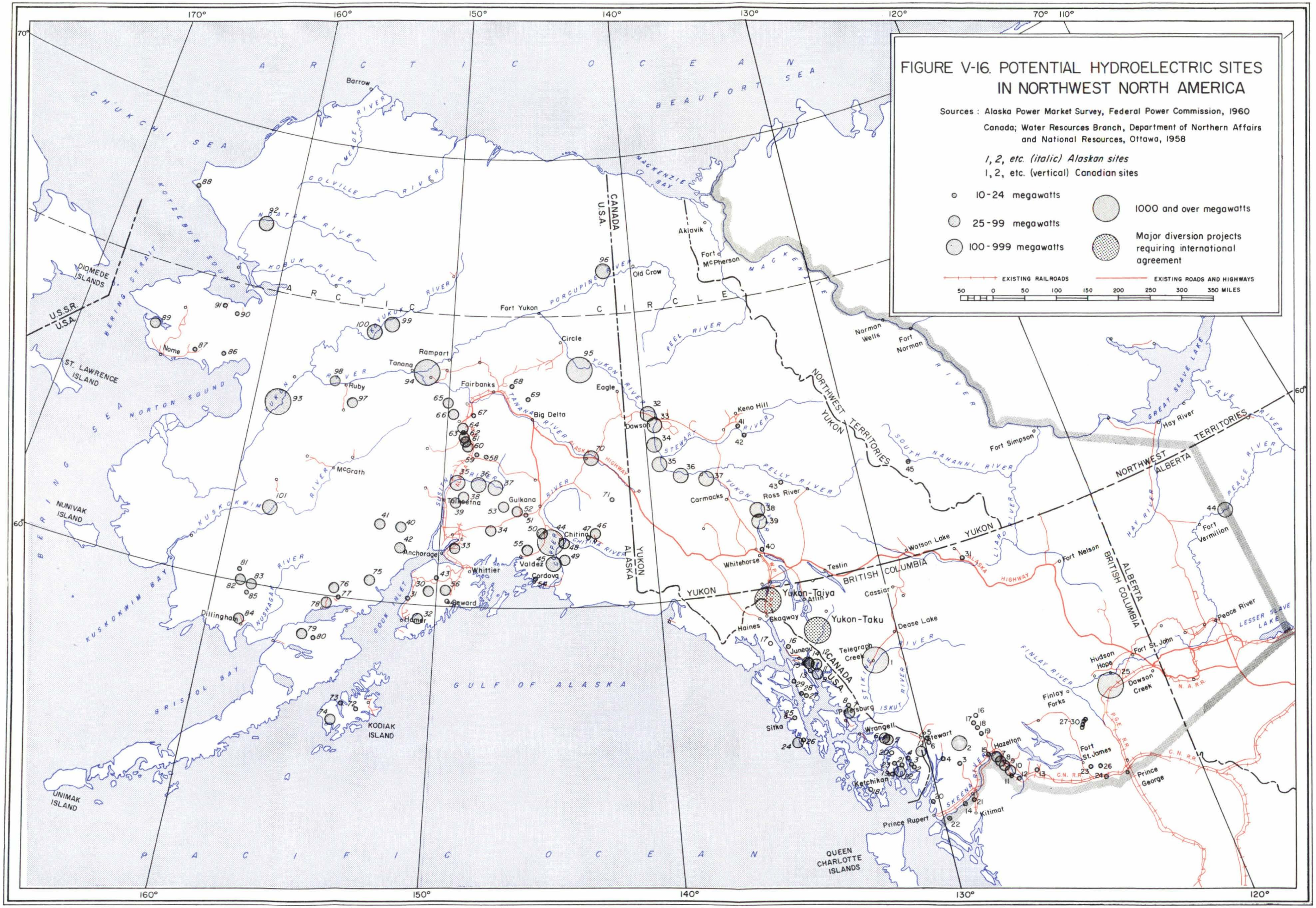
FIGURE V-16. POTENTIAL HYDROELECTRIC SITES IN NORTHWEST NORTH AMERICA
Sources : Alaska Power Market Survey, Federal Power Commission, 1960
Canada; Water Resources Branch, Department of Northern Affairs and National Resources, Ottawa, 1958
1, 2, etc. (italic) Alaskan sites
1, 2, etc. (vertical) Canadian sites
10-24 megawatts
25-99 megawatts
100-999 megawatts
1000 and over megawatts
Major diversion projects requiring international agreement
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
A R C T I C O C E A N
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
GULF OF ALASKA
P A C I F I C O C E A N
A R C T I C C I R C L E
Barrow
Nome
Tanana
Rampart
Ruby
McGrath
Fairbanks
Big Delta
Fort Yukon
Circle
Eagle
Old Crow
Aklavik
Fort McPherson
Dawson
Keno Hill
Carmacks
Ross River
Whitehorse
Teslin
Watson Lake
Fort Nelson
Fort Simpson
Norman Wells
Fort Norman
Hay River
Fort Vermilion
Peace River
Anchorage
Talkeetna
Gulkana
Chitina
Valdez
Cordova
Whittier
Seward
Homer
Dillingham
Haines
Skagway
Atlin
Juneau
Telegraph Creek
Dease Lake
Cassiar
Petersburg
Wrangell
Sitka
Ketchikan
Stewart
Hazelton
Kitimat
Prince Rupert
Finlay Forks
Fort St. James
Prince George
Hudson Hope
Fort St. John
Dawson Creek
Yukon-Taiya
Yukon-Taku
KODIAK ISLAND
UNIMAK ISLAND
NUNIVAK ISLAND
ST. LAWRENCE ISLAND
DIOMEDE ISLANDS
QUEEN CHARLOTTE ISLANDS
U.S.S.R.
U.S.A.
CANADA
ALASKA
YUKON
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
GREAT SLAVE LAKE
LESSER SLAVE LAKE
COOK INLET
BRISTOL BAY
KUSKOKWIM BAY
NORTON SOUND
KOTZEBUE SOUND
BERING STRAIT
MACKENZIE BAY
ALASKA HIGHWAY
C.N. RR.
N.A.R.R.
P.G.E. RR.

conditions, generating capacity is added above that required for the firm power output for reasons such as to provide capacity for use during peak-load periods, to facilitate plant maintenance, and to permit more favorable use of the available water. Large differences in values assigned to installed and prime capacities for some undeveloped sites in the Yukon River area may be attributed to the highly preliminary nature of available water-flow data; however, capacities are shown as listed in the source material.

The total hydro-power potential for some rivers is made up of multiple power sites some of which depend for the output listed upon water regulation by upstream dams. In including all sites in the total listing, it is assumed that development of the power potential would proceed according to plan. Diversion projects, such as the Taiya and Taku proposals for the headwater system of the Yukon River, will affect the flow of water downstream and the potential power production at downstream sites. The listing of undeveloped water-power potential by the Canadian Water Resources Branch does not include major river-diversion projects in the Yukon system. Instead, the power potential of the Canadian portion of the Yukon system is listed under river sites in Yukon Territory.

Neither the U. S. Federal Power Commission nor the U. S. Army Corps of Engineers includes the Yukon-Taiya diversion project in its listing of potential projects. This and the Yukon-Taku diversion project are described briefly in a separate section that follows discussion of Canadian potential sites later in this hydro section.

Brief accounts of some of the well-known and major potential hydroelectric sites are given in the paragraphs which follow. Where references to power casts are encountered, the terms "high cost" and "low cost" are frequently used in a relative sense without clarification. It must be assumed that the terms are with reference to cost bases for the entire U. S. and not to a local area. The average cost of utility electric-power production in the U. S. at the bus bar is between 6 and 7 mills per kwhr. Hence, we may assume that "low-cost" power refers to generating costs that are something below 5 mills per kwhr, and that "high-cost" power is in reference to costs of more than 10 mills per kwhr.

Southeastern Area. Some 200 potential hydroelectric sites in this area offer numerous opportunities for generation of electric power. Most are in the range of capacities up to 10,000 kw of prime power, with a few larger projects having potentials ranging up to 50,000 kw. The abundant precipitation and high heads available at so-called "perched" lakes offer relatively low-cost power even at some of the sites of small capacity.

Greatest interest at the present time is in the Crater-Long Lakes Division of the Snettisham project, located near the mouth of the Speel River, 28 miles southeast of Juneau. Water would be delivered by tunnels and penstocks from Long and Crater Lakes to a generating plant on the Speel River, where 48,000 kw of prime power would be developed. The principal and interest for total investment costs of about $40,000,000 would be repaid over a period of 50 years by a 6.1-mill rate for firm energy and a 4.0-mill rate for nonfirm energy. The establishment of a proposed newsprint mill in the area would justify proceeding with the construction of this power project in the near future. Another 36,000 kw of power could be added to the system at Speel River, but at higher cost, possibly of the order of 10 to 11 mills per kwhr.

Cook Inlet and Tributaries. Numerous water-power sites are available in this area, the largest being sites at Devil Canyon, Watana and Denali on the Susitna River. With upstream regulation and storage at Watana and Denali, the prime power capability at Devil Canyon is estimated to be about 240,000 kw; without the upstream regulation about one-third of this capacity could be developed. Of the other sites in this area, the Eklutna project has been built and is in operation, the Cooper Lake project on the Kenai Peninsula is under construction, and a third project at Crescent Lake has been recommended for construction by the Corps of Engineers. The hydro-power sites in this area are well distributed to serve the demands of the Rail belt area or possible demands for the processing of any minerals that may be present in the region.

Copper River and Gulf Coast. A number of relatively small potential hydro sites are located in this area. Of the larger ones, the site at Wood Canyon on the Copper River, below the mouth of the Chitina River, is one of the more attractive projects in Alaska, costwise and locationwise, according to various studies. Prime power is estimated at 1,280,000 kw with installed capacity of 1,710,000 kw.

Further downstream, at the Peninsula site, another 490,000 kw of prime power could be generated, provided upstream regulation at Wood Canyon was accomplished.

Tanana River Basin. The Cathedral Bluffs site on the Tanana River, 65,000 kw of prime power, represents the largest single power capacity in this area. However, with full development of sites on the Nenana and Jack Rivers, operated as a system, the F. P. C. estimates prime power capacity of 150,000 kw for that over-all project. A number of other sites are available in the range of from 5,000 to 20,000 kw of prime power.

Southwestern Alaska. The potential hydro capacity of this area is about 375,000 kw of prime power divided among 16 sites. The two largest are at Nuyakuk-Tikchik and at Kukaklek Lakes, with prime capabilities of 70,200 and 64,300 kw, respectively.

Northwestern Alaska. This region comprises the Arctic and Seward Peninusla areas. Of the several sites in the Arctic area, those on the Noatak River are by far the largest. Only preliminary studies of power development on the Noatak River system have been made thus far by the Army Corps of Engineers. Estimates of prime capacity for a two-dam project have varied between 278,000 and 325,000 kw. Some of the possible sites on the Seward Peninsula would yield relatively high-cost prime power. However, a site on the Imuruk River, could deliver an estimated 45,000 kw of low-cost prime power.

Yukon and Kuskokwim River Basins. Even without inclusion of the large potential developments in the headwaters of the Yukon in Canada, the Yukon River in Alaska represents one of the finest power rivers in the world. In terms of prime power, more than half of the potential hydroelectric capacity of Alaska is represented by this river system. The site at Rampart Canyon is the largest. Preliminary estimates place the prime power to be developed at something over 3.5 million kw, with installed generating capacity of about 4.7 million kw. As presently visualized, a concrete dam 2,700 feet long at the crest and 500 feet high would create a storage reservoir covering an area of over 10,000 square miles, a surface area greater than that of Lake Erie. With a usable head of about 440 feet and a regulated flow of about 118,000 cubic feet per second, low-cost power estimated to be in the range of 2 to 4 mills per kwhr could be made available.

Obviously, a project of the enormity of a Rampart could not be planned, designed and built in a short time; the Army Corps of Engineers estimates from 12 to 15 years would be required under optimum conditions. Detailed studies including mapping and drilling are in progress, which will take about 4 years to complete. Uses for the enormous output of this project to justify a 1 to 1.5 billion dollar investment present a major problem. The low-cost power from this project is contingent upon full use of the output. The possibilities of stage development have not been determined.

It has been suggested that electric power could be transported by ultrahigh-voltage transmission lines from the Rampart site to serve practically all areas of Alaska. Mention has been made, for example, of Anchorage, Cordova, Seward, and other lower mainland communities having ice-free industrial sites available but involving transmission distances of several hundred miles. Transmission at ultrahigh voltages according to these suggestions is associated with resulting low cost. However, high-voltage transmission per se is not the prime criterion for transmission of low-cost power.

The economics of such transmission systems are predicated first and foremost upon the transport of large blocks of power at relatively high load factors. Transmission costs are too high to transport electric power for small or irregular power demands for long distances. With factors of distance, size of load, load factor, and voltage influencing the cost of transmission, it is difficult to generalize, and costs must be calculated for specific conditions. Hence, the feasibility of a very large power-generating plant such as the Rampart and the transmission of that power within Alaska is contingent upon the establishment of a large number of heavy power-consuming industries in concentrated areas to utilize the output.

Two other sites on the Yukon, at Woodchopper Creek about 100 miles from the Alaska-Canada border and at Kaltag on the lower reaches, have potential prime power capacities of about 2 million kw each. South of the Yukon, at Crooked Creek on the Kuskokwim River, another site having a firm power potential of some 430,000 kw presents further possibilities for development.

Northwestern Canada

Table V-19 is a compilation of the major potential hydroelectric sites of northwestern Canada as given by the Water Resources Branch, Department of Northern Affairs and Natural Resources. Sites having capacities of less than 2000 kw at conditions of continuous maximum flow are not listed. The total capacity listed for this region, 8,790,385 kw at ordinary continuous 6 months' flow, represents about 13 per cent of the undeveloped water-power resources of Canada. This may be considered to be the minimum water-power possibility of northwestern Canada, since some potential sites have not been listed because of insufficient data. The kilowatts of installed capacity for each of the power sites listed would be larger than the water-flow capacities indicated in order to permit higher optimum use of the water.

TABLE V-19. POTENTIAL UNDEVELOPED HYDROELECTRIC SITES IN NORTHWESTERN CANADA[a]

Site	Kilowatts Minimum Flow[b]	Kilowatts Maximum Flow[b]
Northern British Columbia		
1. Stikine River	1,500,000	1,500,000
2. Nass River	336,000	336,000
3. Seaskinnish River	21,000	21,000
4. Anyox Creek	8,950	8,950
5. American Creek	1,870	5,220
6. Bitter Creek	710	3,560
7. Bulkley River	62,700	62,700
8. Bulkley River	36,200	36,200
9. Bulkley River	43,700	43,700
10. Bulkley River	23,100	23,100
11. Bulkley River	5,220	5,220
12. Bulkley River	4,620	4,620
13. Fulton River	2,820	2,820
14. Shames River	2,040	6,350
15. Skeena River	18,950	18,950
16. Skeena River	9,325	9,325
17. Skeena River	2,660	11,100
18. Skeena River	2,130	8,950
19. Skeena River	2,540	10,700
20. Union Creek	3,580	3,580
21. Zymoetz River	8,950	8,950
22. Khtada River	7,230	7,230
23. Stuart River	5,400	5,400
24. Stuart River	3,150	3,150
25. Peace River	3,000,000	3,000,000
26. Cascade River	2,530	2,530
27. Nation River	10,620	10,620
28. Nation River	14,300	14,300
29. Nation River	10,400	10,400
30. Nation River	12,830	17,200
31. Smith River	3,120	--
Total for Northern British Columbia	5,166,645	5,201,825
Yukon Territory		
32. Yukon River	194,000	194,000
33. Yukon River	228,000	228,000
34. Yukon River	353,000	353,000
35. Yukon River	379,000	379,000
36. Yukon River	402,500	402,500
37. Yukon River	655,100	655,100
38. Yukon River	517,000	517,000
39. Yukon River	741,000	741,000
40. Yukon River	11,200	11,200
41. Mayo River	1,790	5,370
42. Stewart River	5,450	16,250
43. Pelly River	600	2,090
Total for Yukon Territory	3,488,640	3,504,510
Alberta		
44. Peace River	74,600	74,600
Northwest Territories		
45. South Nahanni River	3,800	9,450
Grand Total for Area of Interest	8,733,865	8,790,385

(a) Source: Water Resources Branch, Department of Northern Affairs and National Resources, Ottawa. Estimates for Peace River from other published sources.
The proposed Taku diversion project is not included in the total of the area for British Columbia of interest, following the reporting method used by the Water Resources Branch, Department of Northern Affairs and National Resources, which does not include the power potentials of major river diversions that have been investigated but not developed.
The hydroelectric power potential of the Yukon River is listed under Yukon Territory. Also, there may be problems related to this that would require international agreement between Canada and the U. S.

(b) Minimum flow is based on the continuous power available for the average of the mean flows for the two lowest periods of 7 consecutive days in each year covered by the period of record. Maximum flow is based on the ordinary 6 months' flow which is the computed stream flow usually available for at least 6 months in the year. Power is based on 80 per cent efficiency.

Some of the major potential hydro-power sites in northwestern Canada are described briefly in the following paragraphs.

Northern British Columbia. The development in this area currently receiving most attention is the site near Hudson Hope on the Peace River. Engineering investigations by the Wenner-Gren-British Columbia Development Company, Ltd., in 1957, showed that some 4 million hp of electricity could be developed at the canyon section of the Peace River near Portage Mountain (1 hp is equivalent to 0.746 kw). The Peace River Power Development Company, Ltd., was formed to plan and carry out a scheme of development. Under an agreement reached by this company with the Government of British Columbia, a report covering the feasibility of the project was submitted to the Comptroller of Water Rights for British Columbia in December, 1959. After reviewing the report, the Comptroller announced on March 25, 1960, that the proposed development was feasible from an engineering viewpoint, with a few reservations, and the Minister of Lands and Forests advised the Development Company that the necessary applications for the required certificate and license could be made to the Public Utilities Commission and to the Water Rights Branch. When these are obtained, the company will be committed to start work immediately on preliminary site work and construction of a pilot tunnel. Thenceforth, work would proceed until completion of the whole project by 1976. Plans call for power from the first stage to be available in 1968, with an output of about 750,000 hp (560,000 kw).

The main Portage Mountain Dam is envisaged to be 600 feet high and over 7,000 feet long constructed of rock and earth fill with an impervious clay core. The power house will be located nearby. The dam will create a reservoir extending for 80 miles westward on the Peace River and thence for about 200 miles from north to south along the Rocky Mountain Trench. The total volume of water impounded will be 88 million acre-feet of which about 30 million will be usable for live storage. Eventually, the Peace River development is expected to be an important factor in a proposed Pacific International Power Pool. When completed, the total generating capacity is expected to be 3,145,000 kw. A 500,000-volt transmission line is planned from the generating plant to connect with the transmission system of the British Columbia Electric Company at Lillooet, a distance of about 450 miles, with other lines to the Vancouver and Victoria areas. The line could also serve other cities and towns in northern and central British Columbia through the system of the British Columbia Power Commission.

Developers of the project have stated that electric power from the Peace River development could be sold in the lower mainland area of British Columbia at 6 mills per kwhr. Industrial loads for utilization of the large output from this project are minor at the present time in the area of the project, and a long-term period for industrial development of the contiguous areas would be required. In the meantime, the power output would have to be sold in the southern area of British Columbia and perhaps below the border in the U. S. This is an area that might also be served by power developments on the upper Columbia River, which are being intensively studied by government agencies on both sides of the border through the International Joint Commission.

Since the whole area involved cannot for many years support both developments, a controversy of some magnitude has developed involving factors of politics within Canada, economic facets which have not yet been fully appraised, a background of public versus privately developed power, markets and market development, and many questions of an engineering and technical nature. Basically, the problem is not one of availability of hydro-power sources, but one of assessing the technical and economic problems of establishing large low-cost power developments in an orderly fashion compatible with present and anticipated electric-power demands.

The second largest potential power site is on the Stikine River where an estimated 1,500,000 kw could be made available. Additional sites are available on the Bulkley and Skeena Rivers, and a large number of other locations of smaller potential are in this area. Excluding the Yukon-Taku diversion project (described later), a total of more than 5 million kw of power is available in the northern British Columbia region.

Yukon Territory. The principal hydro-power resource of Yukon Territory is on the Yukon River. The potential for the Yukon River in Yukon Territory itself is listed by the Water Resources Branch as being some 4,000,000 hp. As outlined in the previous section, however, the Yukon-Taku diversion project which provides relatively high heads to the low valleys in British Columbia appears to offer the best possibilities for the production of low-cost power. To use directly the flow of water in the Yukon River itself would involve the construction of a number of large and expensive dams, since there are no locations offering the possibilities of a concentrated head, as evidenced by the fact that the river is navigable throughout the area.

Other than the possibilities of power projects on the Yukon River, only a few small hydro-power sites are known in the territory.

Alberta. Only one major water power site is listed for the northwestern section of Alberta of interest in this study. This is the Vermillion Falls site on the Peace River, where a potential development of about 75,000 kw could be located. The abundant resources of fossil fuels in Alberta will permit development of thermally derived electric power in proportion to the anticipated demand, especially for the western half of the Province.

Northwest Territories. For that portion of the Northwest Territories of interest in this study, west of the Mackenzie River, only one small hydro-power site is listed. This is a site on the South Nahanni River at Virginia Falls, where a potential of about 10,000 kw could be developed.

Power Sites Involving International Agreements

The two power projects that have had widest publicity in connection with planned promotions in the past decade contain elements that would require international agreements between the U. S. and Canada. These would both involve diversion of flow of large lakes in headwaters of the Yukon, and drop such diverted waters with heads of some 2000 feet to (1) the Taiya Valley near Skagway, and (2) the Taku River in Canada east of Juneau.

Yukon-Taiya Project. After a detailed engineering survey, the Aluminum Company of America announced on August 23, 1952, that plans had been completed to generate power through the diversion of the headwaters of the Yukon River through a tunnel, into the valley of the Taiya River, near Skagway, thus creating a fall of over 2000 feet.

This project involved the construction of a dam on the Lewes River at Miles Canyon, 6 miles upstream from Whitehorse. This dam would raise the water level of five lakes: Atlin, Tagish, Marsh, Bennett, and Lindeman. Lake Lindeman, the southernmost member of this chain of lakes, would be connected with the powerhouse site by a 13-1/2-mile tunnel. This powerhouse (No. 1) was to be equipped with eight 100,000-hp turbines, and would be completely underground. The mill race from Powerhouse No. 1 would connect, by a 7.7-mile tunnel, to Powerhouse No. 2, also underground, also equipped with eight 100,000-hp turbines. Due to the tremendous storage capacity represented by the lakes listed above, and because of the substantial flow under the ice, the Taiya project was expected to generate power throughout the year on a continuous basis.

An aluminum reduction plant, with an initial capacity of 200,000 tons of metal annually, was to be constructed in the Taiya Valley. It was anticipated that the alumina for this plant would come from Alcoa's Caribbean sources and would be delivered to the Taiya plant by marine ore carriers. The returning vessels would transport aluminum ingot to West Coast and Gulf ports, via the Panama Canal.

It was anticipated by Alcoa that the aluminum reduction works, and the necessary hydroelectric facilities, would give ultimate employment to some 4,000 persons, thus providing the wage earning base for a community of some 20,000 inhabitants. The estimated cost of the entire project, both the hydroelectric and aluminum reduction facilities, was $400 million.

Following the announcement, Canadian opposition developed, despite the obvious benefits to communities on both sides of the Canadian-Alaskan border. Without permission to utilize the Yukon headwaters, the Aluminum Company of America was forced to abandon its plans. Notification of the cancellation of the Taiya project was made on March 1, 1957, 4-1/2 years after the initial plans had been announced. Since then, changes in the comparative costs of hydro- and thermally-generated electric power and in various pertinent transportation and other economic factors have resulted in Alcoa's present disinterest in reviving its plans even if approval of the Canadian government could be obtained.

Yukon-Taku Project. This has been described as an all-Canadian project completed within Canadian boundaries, for which preliminary studies were made in the mid-1950's by Ventures-Frobisher-Quebec Metallurgical Industries, Ltd. International problems relating to changes in flow of the Yukon and Taku Rivers might well require international agreement, however. The plan visualizes stage construction beginning at about 200,000 kw of power output and reaching 3,600,000 kw through four stages of construction. The project through the second stage involves raising the level of the large headwater lakes – Atlin, Bennett, Lindeman, Tagish, Taku Arm, and Marsh Lakes – by a dam several miles above Whitehorse, thus creating a huge reservoir. From Atlin Lake water would flow through a tunnel to Sloko Lake, from which a 10-mile tunnel would deliver the water into a generating station on the Nakonake River under a gross head of 1,090 feet. An estimated 650,000 kw would be generated at this station. By adding water from Teslin Lake to the available water to be delivered to the Nakonake River generating plant, through the construction of a dam and diversion tunnel, the power output could be increased to 1,100,000 kw. Two further stages, not yet firmly detailed but including a tunnel between the Nakonake and Taku Rivers, additional diversion of water, and another generating station, would raise the output to a total of about 3,600,000 kw.

Power Costs

Power costs in Alaska are high for a number of reasons, including the generally higher costs of construction, labor, fuels, transmission lines, and transporation of essential materials.

By way of comparing costs of electricity for residential use in Alaska with several locations in the rest of the U. S., the cost of using 280 kwhr per month is shown in the following tabulation, using published rate schedules:

Alaska		Other States	
Fairbanks (S)	$19.50	Grand Forks, N. D. (S)	$9.75
Seward (D)	18.30	Bangor, Maine (S)	9.41
Cordova (D)	16.20	Columbus, Ohio (S)	8.10
Anchorage (H, S)	10.54	Dallas, Texas (S)	7.33
Juneau (H)	9.13	Renton, Wash. (H)	5.32
Ketchikan (H)	7.13	Nashville, Tenn. (H, S)	5.30

(S = steam power; H = hydro; D = diesel)

Monthly costs of residential electricity in Anchorage, Juneau, and Ketchikan, where hydro-derived power is available, are comparable to those in other states, where electricity is thermally generated. Where power in Alaska is thermally derived by steam or diesel, the cost to consumers is much higher. Utility rates for industrial power, seldom available, are also high.

Power Costs From Alaska's Potential Hydroelectric Sites

Small Hydro-Power Projects. As mentioned previously, the potential hydroelectric sites that have been studied in detail sufficient to permit the making of reliable estimates of generating costs are relatively few in number. Many of the potential water-power developments represent relatively high-cost power (costs of more than 10 mills per kwhr at the bus bar) such as that potentially obtainable at most of the smaller sites in the Copper River and Alaska Gulf Coast areas, the Tanana River basin, and southwestern Alaska. Many of the smaller potential hydroelectric sites of interest are to be found in Southeastern Alaska. In 1954, the Army Corps of Engineers made estimates of generating and construction costs for 12 of the sites in this area. Estimates were based on 3 per cent interest charges for an amortization period of 50 years. Table V-20 shows the results of the study. Of the 12 sites studied, 6 were in the range of costs of from 5.3 to 7.0 mills per kwhr for firm output, 3 were in the range of 8.8 to 9.7 mills, and 3 were over 10.2 mills.

TABLE V-20. ESTIMATED CONSTRUCTION AND GENERATING COSTS OF SELECTED HYDROPOWER SITES IN SOUTHEASTERN ALASKA[a]

Project	Kilowatts		Estimated Costs (1954)	
	Installed Capacity	Prime Power	Construction, millions of dollars	Firm Energy Generation, mills per kwhr
Juneau Area				
Speel River	72,000	36,000	68.7	10.3
Long Lake	42,000	21,000	17.0	5.3
Crater Lake	22,000	11,000	10.4	6.4
Dorothy Lake	28,000	15,000	13.5	6.0[b]
Ketchikan Area				
Swan Lake	15,000	7,630	10.8	9.0[c]
Lake Grace	22,200	11,000	11.5	7.0
Mirror, Ella, Manzanita Lakes	29,600	14,500	24.00	9.7
Petersburg-Wrangell Area				
Cascade Creek	34,000	16,900	16.6	6.2
Scenery Creek	18,000	9,000	13.0	8.8
Sitka Area				
Green Lake	4,800	2,400	4.8	12.6
Blue Lake[d]	15,000	7,400	12.0	10.2
Takatz Lake	15,000	7,600	6.5	6.2

(a) Source: "Water Resources Development by the U. S. Corps of Engineers in Alaska" (January, 1959).
(b) Recent studies show 7.2 mills per kwhr for assumed power market pattern.
(c) 1959 estimate shows 11.8 mills for prime power with immediate market for all power; 15.4 mills per kwhr assuming power market pattern similar to past and present load growth.
(d) Under construction.

Estimated power costs have also been made by the Corps of Engineers for other hydro-power sites in Alaska. The sites in the Cook Inlet drainage area are of interest because of their location. Based on a 50 per cent load factor, 3 per cent interest charges, and 50-year amortization, Corps of Engineers cost estimates for firm power at 6 of the sites are shown in Table V-21.

TABLE V-21. ESTIMATED POWER COSTS OF SOME SMALLER HYDRO-POWER SITES IN THE COOK INLET AREA[a]

Project	Kilowatts Installed Capacity	Kilowatts Prime Power	Estimated Costs, Firm Energy Generation, mills per kwhr
Cooper Lake[b]	8,900	4,450	7.8
Crescent Lake	9,500	4,750	8.3
Kasilof River	24,000	12,000	9.0
Grant Lake	5,900	2,950	11.1
Ptarmigan Lake	4,700	2,350	11.4
Bradley Lake	--	23,000	4.42

(a) Source: "Water Resources Development by the U. S. Corps of Engineers in Alaska" (January, 1959).
(b) Under construction, 15,000-kw capacity.

With few exceptions, preliminary estimates of generating costs at the smaller sites in areas of the Copper River and Gulf Coast, Tanana River basin, and southwestern Alaska are more than 10 mills per kwhr. However, a large number of these are in the borderline class of between 10 and 15 mills per kwhr, and thus are available for power development at reasonable cost, although far above what would be considered to be low-cost power for industrial use.

If it is assumed arbitrarily that the smaller projects include capacities of up to 50,000 kw, the Snettisham project (Long-Crater Lakes division) may be mentioned at this point. This is a relatively low-cost potential power development of immediate interest and feasibility. The feasibility of going ahead with this project is based on the availability of a 30,000-kw load for firm power for a projected newsprint mill under consideration by the Georgia-Pacific Alaska Company. The estimated power cost of 6.3 mills per kwhr is somewhat less than the 7.0-mill level which is believed to be the upper limit of power costs for a mill operation of this type. With the mill taking a large part of the output from the Snettisham project, it has been estimated that the firm power generated would be fully utilized by the power market pattern of the area within several years after completion. Alternatively, power from this site might be used in the combination pretreatment-electric furnace smelting of Snettisham iron-ore concentrates, as discussed in some detail in the "Metals and Minerals" section of this chapter.

The Lake Dorothy project is considered to be a good development to supplement the Long-Crater Lakes division when necessary. The Speel River project, at somewhat higher cost, is also available.

It can be concluded that there are a number of small potential hydro-power sites in Alaska which are available to serve local needs.

Large Hydro-Power Projects. When reference is made to the availability of truly low-cost power in Alaska, it is projects of the size and type of the Rampart, Yukon-Taiya, and Wood Canyon sites that are brought to mind.

Situated as it is in the Rail belt area of Alaska, the Devil Canyon project on the Susitna River has been given considerable study, including a projected power market pattern for the area. A four-dam development in stages is possible on the Susitna River, with the production of relatively low-cost power estimated to be in the range of 5.0 to 6.0 mills per kwhr. More exact cost estimates will be available from feasibility and power market studies currently in progress. The initial project involves dams at Devil Canyon and Denali resulting in a generating capacity of 500,000 kw, with construction costs estimated to be of the order of $360 million*. When required, two additional power dams could be built above Devil Canyon (Vee and Watana), which would add more than 500,000 kw of additional capacity. Power to be derived from this project could be expected to serve the needs of the Rail belt area for the foreseeable future, including civilian and military requirements and hoped-for industrial loads.

The Rampart project on the Yukon River is currently the subject of great interest since it offers the possibility of enormous capacity and truly low-cost power. Studies of this site are only in a preliminary stage, but enough is known to suggest that about 3,500,000 kw of prime power could be developed at costs in the range of 2 to 4 mills per kwhr with full use of the output. Actual costs, of course, would depend upon the results of more detailed studies of the feasibility and costs of stage development, and particularly upon the power market pattern. Obviously, such a large output could only become feasible if a number of heavy power-consuming industries could be located in the area. Navigation and fishery problems must be given serious consideration on this project, particularly since the Yukon River has its headwaters in Canada.

Two other large potential power projects on the Yukon River system, at Kaltag and Woodchopper Creek, show prime power capacities of 1,770,000 kw and 2,030,000 kw, respectively. Cost estimates at these locations are not available.

The Wood Canyon site on the Copper River is another outstanding potential power development. Preliminary estimates show the possibility of producing 1,280,000 kw of prime power at costs of about 3.5 mills per kwhr assuming full utilization. Fishery problems are involved on this project.

In studies given the Yukon-Taiya project by the Bureau of Reclamation, published in 1955, the initial capacity of the project was 340,000 kw. Further development by stages was planned to give an ultimate capacity of 900,000 kw. At interest charges of 2-1/2 per cent over 50 years, average power costs in 1951 were calculated by the Bureau to be 2.1 mills per kwhr at full and constant utilization. As already noted, permission to use the Yukon headwaters in this manner was refused by Canada, and interest of Alcoa in the project has been dropped completely. Current or future construction costs would be higher than the 1951 levels used in the above estimate, and a realistically higher interest charge would combine to give power costs substantially above the 2.1 mills mentioned above.

*Water Resources Activities in the United States. Water Resources of Alaska. Select Committee on National Water Resources. United States Senate, Committee Print No. 19, January 1960.

Power Costs From Northwestern Canada's Potential Hydroelectric Sites

Few estimates of power costs are available for the undeveloped water-power sources of the northwestern area of Canada of interest for this study.

Statements have been made that power costs for the proposed Peace River project will be about 6 mills per kwhr delivered to points in the lower mainland areas of British Columbia. Since transmission costs are included in this cost estimate, power for industrial use in the area of the generating station should be appreciably less.

The cost of power for the first stage of development of the Yukon-Taku power project has been estimated by Quebec Metallurgical to be about 3.6 mills per kwhr at an 85 per cent load factor for 650,000 kw. Development of the second major stage to produce 3,200,000 kw would result in a power cost of 3.3 mills per kwhr. Interest charges on capital for private financing of the venture were figured at 7 per cent.

Potential Uses and Markets

Development of major power-consuming industries in Northwest North America is contingent on the availability of low-cost electric power, previously defined for purposes of this report as below 5 mills. Such major power-consuming industries must look to markets for their products in major consuming areas in the U.S. and throughout the world – especially in countries bordering the Pacific Ocean. In these areas power from Northwest North America must compete with low-cost power from all these other areas in producing the products involved.

Prime examples of low-cost electric power are (1) the Columbia River system under the Bonneville Power Administration, and (2) the Tennessee Valley Authority. At Bonneville, minimum base rates have been as low as 2 mills per kwhr, which has been a prime factor leading to the establishment of the aluminum and other electrometallurgical and electrochemical industries in that area. Rates to large power consumers in the TVA area are something over 4 mills per kwhr. Both systems are publicly financed at low interest and tax rates.

In recent years, large integrated coal-fired plants in the Ohio River area, privately operated, have demonstrated their ability to produce low-cost power for aluminum-reduction and uranium-enrichment plants at power costs in the range of about 4 mills per kwhr.

Although undeveloped hydro sites in the 48 states are becoming relatively scarce, reserves of coal for producing low-cost power are still huge, and large amounts of these reserves still remain in areas close to major centers of population and markets. Large undeveloped hydro sites are scattered elsewhere throughout the world, and many of these are located close to sources of raw materials, the processing of which requires large amounts of low-cost power. Coal deposits elsewhere in the world can provide low-cost fuel to generate thermally produced low-cost electricity.

In short, events in the past couple of decades have resulted in reduced interest in large-scale use of hydro power in Northwest North America. This has arisen from: (1) the fact that hydro-power costs have gone up substantially during that period (dam construction and cost of the huge turbines and other machinery needed) while the costs of thermally generated power have remained relatively level or even been reduced, resulting in the virtual disappearance of the margin between the two; and (2) growing interest in use of hydro- or thermally-generated power in other parts of the world, closer to available resources to be processed by use of the power. Nationalistic trends in foreign areas are forcing more and more use of local power to process indigenous raw materials to higher levels of manufacture.

If and when developed, the large-scale projects in Alaska, Yukon Territory, and northern British Columbia can be expected to furnish low-cost power. However, the economic feasibility of such large developments is dependent upon firm, long-term contracts from electric-power-oriented industries requiring large blocks of power for their product, examples of which are the production of aluminum (about 19,000 kwhr per ton), titanium (45,000 kwhr per ton), elemental phosphorus (12,000 kwhr per ton), and enriched uranium, the heaviest electric-power consumer of all metals. Industries producing rayon (5,200 kwhr per ton), electrolytic zinc (3,400 kwhr per ton), and electric-furnace pig iron (1,100 to 2,400 kwhr per ton) are less power oriented but substantial consumers.

For most manufacturing industries, the availability of low-cost electric power is not decisive but is only one of a large number of factors influencing the location of a plant. Location with respect to raw materials, taxes, transportation costs, labor supply, and nearness to markets may be of equal or greater importance. Electric power must be available, but its cost is seldom the outstanding factor influencing a decision on specific location of an industrial plant.

The Federal Power Commission completed a report in May, 1960 ("Alaska Power Market Survey"), made at the request of the Army Corps of Engineers, which presented estimates of the future growth in electric-power production in Alaska. It was estimated that the total electric-utility capacity would increase from 108,000 kw as of the end of 1957 to 356,000 kw in 1980. The capacity for both years includes present military installations, but the 1980 estimate did not undertake a forecast of possible expansion in the military category. The estimated increase in capacity was on the basis of normal load growth, and did not include possibilities for the development of industries which would use power from some of the major potential hydro-power sites in Alaska, although such possibilities were given recognition.

From this estimate, it is evident that normal load growth would involve only a small part of the power inherent in the development of any of the large low-cost hydro-power potential. Markets for large blocks of power from these hydro-power sites would have to be furnished by development of heavy power-consuming industrial loads, as already indicated.

Representative companies in major industries that are potential consumers of power in the Area were interviewed by Battelle, including manufacturers of aluminum, ferroalloys, pig iron and steel, calcium carbide, chlorine, caustic soda, and phosphorus. Generally speaking, interest was decidedly cool or outright cold. In addition to the reasons cited above, companies cite the location economics as a major obstacle – the long distances involved in transporating raw materials to the Area to use the power in processing, followed by long-distance transportation of products to markets. Known raw-materials in the Area for processing by power are decidedly limited – no bauxite for aluminum, virtually no chromite for ferrochromium, no salt or brine deposits for chlorine and caustic soda, pure silica deposits are scarce, and phosphate deposits are relatively low grade and inaccessible.

Moreover, with respect to aluminum reduction – a major user of power – consideration must be given to the fact that Kitimat (only a short distance south of Prince Rupert on the coast) has large unused power potential already partially developed that can be applied to additional aluminum production when markets warrant doing so. The dam at Kemano (supplying Kitimat) has impounded sufficient water for an ultimate total installed generating capacity of the order of 2,240,000 hp firm (about 1,680,000 kw), permitting production of more than 500,000 tons of aluminum per year. The first stage in this development is completed, including the driving of a 10-mile tunnel and the installation of seven generating units having an installed capacity of 1,050,000 hp (786,000 kw) – sufficient to support production of some 300,000 tons of aluminum per year. The more difficult parts of the transmission lines that run about 50 miles between Kemano and Kilimat are now capable of handling the additional power from the second stage, which would involve the drilling of an additional tunnel, the enlargement of the generating-station cavern, and the addition of more generating units.

Kitimat is now operating at a capacity of 192,000 tons of aluminum per year, with facilities for another 80,000 tons annual capacity partially built and awaiting completion when business warrants. Thus, present aluminum output can be expanded at Kitimat by over 100,000 tons per year without increase in power-generating capacity, and by an additional 200,000 tons per year by expenditure of capital costs for the increased power far below the costs of starting "from scratch" on a hydro-power project. Kitimat is ideally situated to supply growing markets in countries on the Pacific periphery.

Establishment of a pretreatment-electric furnace smelter to convert Klukwan iron-ore concentrate to pig iron or steel would appear to be the most promising potential user of a substantial block of power (say 200,000 kw to produce 1 million tons of steel annually). But this, at best, would be contingent on construction of the dam and power plant by someone else, and sale of power at less than 5 mills per kwhr.

The only type of major power use that could consume the several million kilowatts potential visualized at huge projects such as Rampart, Yukon-Taku, Yukon-Taiya, and Peace River is separation of enriched uranium by diffusion. However, the AEC announced in 1960 that the capacity of existing diffusion plants at Oak Ridge, Paducah, and Portsmouth is more than sufficient to meet estimated demand for military and civilian needs for several decades.

There remains the possibility of tying in such major power sources into huge power networks far to the south. This is now in the planning stage for the Peace River development. However, the vast additional distances and costs involved in moving power from the other projects (Rampart, Taiya, and Taku) to such national networks would appear to preclude their use for this purpose during at least the 20-year period involved in this study.

Competitive Aspects of Energy Sources in Alaska

From discussion of the basic energy resources in this and prior sections of the report, it is evident that Alaska has been favorably endowed with coal and hydro-power resources, and it is becoming increasingly evident that oil and natural gas are available in substantial amounts. It is further evident that the growth of demand for energy in Alaska will not be at a rate sufficiently great to use the full capability of all of these available energy resources; on the contrary, competition among the several sources can be expected to become greater in the future in cities such as Anchorage where natural gas transported from the Kenai Peninsula will soon be available. It must be concluded that for the short-term future, until such time as the demand for energy is built up substantially by normal load growth, and more particularly by industrial load growth, the pattern of fuel usage and markets will be subject to radical change.

Under present conditions in the Anchorage area, for example, electric energy for civilian use is largely supplied by hydro installations, heat and electric power is derived from coal at the nearby military installations, and the general civilian heat and power market is largely supplied by fuel oil. Typical prices of fuels at the present time are as follows:

Fuel	Unit	Heating Value per Unit, Btu	Cost per Unit to User	Cost per Million Btu
Coal (bit.)	Ton	24,400,000	$14.74[a]	$0.58[a]
Oil				
Stove (PS-100)	Gal	139,000	23.7¢	$1.70
Furnace (PS-200)	Gal	141,000	22.5¢	$1.60
Fuel oil (PS-300)	Gal	149,800	13.07¢	$0.87
Propane	Lb	21,650	18¢	$8.30

(a) Delivered prices in small lots to residential users are about 50 per cent higher.

Except for the absence of natural gas in the above listing, the pattern of fuel usage in the U. S. is generally reflected in the use of fuel in Anchorage. That is, coal is used by utility and power plants where basic fuel cost is a major criterion, and a fluid fuel, in this case oil, is used preferentially in the residential and commercial heating market even though the basic fuel cost per million Btu is significantly higher. Factors of automaticity, convenience, and cleanliness largely dictate the choice of fuel for this market.

With the arrival of natural gas in the Anchorage area, it is likely that it will attract a substantial part of the residential and commercial market as fuel for space heating, cooking and water heating. Gas rates for the Anchorage area were announced in the late summer of 1960 by the Anchorage Natural Gas Corporation. Schedule A residential rates filed with the city were $5.00 for the first 1900 cubic feet or less, 20 cents per 100 cubic feet for the next 3100 cubic feet, and 12 cents per 100 cubic feet for all additional gas. These rates compare favorably with those for residential service in Seattle, Washington. The Corporation estimates an annual fuel saving for heating a "typical" house requiring 200,000 cubic feet of gas per heating season at about 25 per cent as compared with oil. Lowest rates, obtainable for interruptible service, were announced at 60 cents per thousand cubic feet, with a minimum monthly bill of $10,000. This would amount to a minimum usage of about 16.7 million cubic feet of gas.

Potential markets for electric power from large projects such as Rampart have been extended by some to include the possibilities of aiding Alaskan residents by making available low-cost electricity for space heating in addition to the more common applications. Although this is a potential market, it should be pointed out that transmission, distribution and other costs multiply the plant bus-bar cost severalfold. Thus, 2- or 3-mill power at the plant would be priced in a range averaging perhaps 10 mills per kwhr by the time it reaches the residence of the customer. At the low average rate of 10 mills (1 cent) per kwhr, the cost of electricity for resistance space heating would be $3.10 per million Btu. Even though electric power is usable for space heating at practically 100 per cent efficiency, compared with about 80 per cent for natural gas, the cost of heat from electric power would be 50 to 100 per cent greater than that from natural gas or oil. This energy cost differential, however, does not necessarily rule out the use of electric heating because in some areas of the southern 48 states the use of electricity for comfort heating has been increasing at a rapid rate in recent years under conditions of similar differentials in costs of energy. The use of heavy insulation in the house and of double glazing of windows is essential for electric heating to keep costs within reasonable limits.

Industrial rates for natural gas in greater quantities than those announced, firm and interruptible, will be determined by negotiation. As in any new gas-pipeline situation, improvement of the load factor on the line will result from the sale of off-peak gas at reduced prices to industry and power plants. It is not unlikely that the price of natural gas could be made attractive enough to interest the Defense Department in supplying a part or all of the fuel requirements of the military installations in the Anchorage area. The decision regarding full use might then have to be made on the basis of consequent hardship on the coal industry and its employees and on the drop in revenues to the Government-owned railroad over which the coal is shipped from the Matanuska coal fields to Anchorage. Since roughly one-half of the coal mined in Alaska finds a market in the Anchorage area, largely at Government-owned installations, the loss in markets would be a major blow to the coal producers and the railroad.

Although a supply of natural gas for the Fairbanks area is not yet in sight, the possibilities of arranging for gas from the Gubik field or an extension of the pipeline from Anchorage has been given consideration. Already, conflicting opinions regarding the cost of gas delivered to military installations near Fairbanks have been aired in the press. As of mid-1960, hopes of gas being brought down to Fairbanks from the Gubik field were cooled considerably by the decision of the Department of Defense to curtail greatly the military activities and personnel at Ladd Air Force Base.

Aside from that used at military installations, coal is used as a fuel for electric-power plants at only three installations, two in Fairbanks and one in Anchorage. The cost of subbituminous coal at the Fairbanks installations is between $10 and $11 per ton or about 60 cents per million Btu. This high cost may be contrasted with that of coal delivered to electric-utility plants in other parts of the U. S. where costs typically are below 30 cents per million Btu in and near the coal-producing areas. A number of large electric utilities in the Ohio River area, for example, obtain coal at delivered costs of 20 cents per million Btu and less. A combination of a lack of assured future markets and mining conditions of more than average difficulty, together with generally high labor and materials costs, has tended to keep coal prices at high levels. This explains the present interest in the Beluga field, where large tonnages of subbituminous coal are believed available in thick seams with thin to moderate cover. This deposit suggests the possibility of low-cost recovery by hydraulic stripping and possibly mining by cheap dredging methods, with delivered costs to Anchorage in the range of 20 to 30 cents per million Btu, or to a mine-mouth thermal-power plant of something like one-half of these costs.

Although new coal-fired utility plants for the generation of electricity have been given some consideration in the past in Alaska, none (except for the plants in Fairbanks) has materialized. The plants installed at military bases have served a dual purpose, that of furnishing both heat and power. Reasons for the lack of interest in coal-fired plants have included (1) the high cost of coal in Alaska, (2) the relatively small size of the plants, and (3) the wide availability of hydro power. Were power demands sufficient to permit the building of a medium- or large-size plant near a field of coal which, for the tonnages involved, could be mined at low cost, a coal-fired plant might be given serious consideration. An example would be one located in the Beluga coal field to serve the Anchorage area.

Construction costs for hydroelectric stations are rising. For example, the costs fo hydroelectric plants at Swan Lake and Dorothy Lake were estimated to be $10,800,000 and $13,500,000, respectively, in 1954. By 1959, the estimates had been revised upward to $16,360,000 and $15,667,000, indicating construction costs of $1090 and $600 per kw for these two installations. The rising costs reflect both increased construction costs and a refinement of estimates.

Although the first cost of hydroelectric plants per unit of capacity is higher than those for thermal plants – the average construction cost of thermal generating plants in the U. S. was about $150 per kw in 1958 and 1959 – they have some important long-term advantages. The rate of obsolescence is lower than that of any type of thermal plant. Operating costs are small, and circumstances of high and increasing labor and fuel costs favor hydroelectric plants. An added advantage is that the useful life of most hydroelectric plants often is substantially longer than the period used for accounting purposes, thus offering still lower real costs over the life of the plant.

In summation, the future energy-use picture in Northwest North America, especially in Alaska, will be characterized by increasingly keen competition among the various energy sources – hydro, coal, gas, and oil, with nuclear sources perhaps becoming competitive in isolated locations a bit farther in the future. This competition is concerned at present with very limited local markets in the Area, and even a doubling or quadrupling of such local markets in the next 20 years will still mean only relatively small demands. Markets for large blocks of the potentially low-cost hydropower in the Area may develop for processing materials, but this power must compete with huge potentials of cheap hydro and thermal power elsewhere in the world. Transmission of large blocks of hydropower from the Peace River region to heavy power-using areas to the south is quite possible by 1980.

FORESTS AND FOREST PRODUCTS

The Resource

Several hundred million acres of forest cover, stretching from Lesser Slave Lake and the Mackenzie River on the east to the Pacific Ocean and Bering Sea on the west, comprise a vast timber resource which has hardly been touched to date. Within this enormous woodlands area are forests - some dense, some sparse; primarily coniferous, but with some admixture of hardwoods; some readily accessible, and some almost inaccessible by present or foreseeable methods of access; some rain forest, and some almost arid land; some mild temperatures, and some severe temperature extremes. In short, the forest area exhibits a degree of complexity and a pattern of growth that arise from and conform to the widely varying topographical and geographical configurations incorporated. But even that fraction of the forest that is sufficiently dense to make timber operations worthwhile, that contains desirable species, and that is either presently accessible or can be made so with reasonable effort, presents an opportunity for a forest-products industry which can, in turn, develop the area so exploited in a stable, profitable manner and make a significant contribution to the future economy of Northwest North America.

A summary of the composition of the woodlands resource, which is discussed in fuller detail in the following sections, is presented in Table V-22, and the scope of the forests encompassed in this study is shown in Figure V-17.

As indicated in Table V-22, the forest resource of Northwest North America is over a trillion board feet, making it, outside of possible timber reserves in the U.S.S.R., the largest relatively untapped coniferous supply in the world. The currently allowable cut on the accessible portion alone is 12 billion board feet annually, enough to support a thriving pulp and paper industry of the type flourishing in the Pacific Northwest with sufficient saw timber and possibly veneer to satisfy not only the internal requirements of the region, but to have an exportable surplus of major proportions. Were all the forests equally accessible, the potential would more than double.

The figures estimated for current annual allowable cut may realistically be conceived of as a conservative minimum, for the following reasons. In the first place, the larger portion of the area has not been surveyed; indeed part has not been explored. Original estimates, deliberately conservative, may be expected to be considerably short of the actual potential, since this has been the uniform experience to date. In the second place, as more and more of the forest is brought under proper management procedures so that (1) overmature and worthless timber is cleared away, and (2) fire control, disease and insect control, and cutting practices show still further the results of the intensive efforts being applied, the resource itself will improve in quality and quantity. It is not unrealistic to envisage by, say, the year 2000 a total timber resource of the area perhaps three times that now estimated. But, in order to remain knowingly conservative, and lacking firm grounds for extension of the resource data into the future on other than a reasonable basis for high hopes, quantitative consideration of the timber available for use will rely on the best measurements and estimates obtaining currently.

Accessibility of the timber resource is, of course, of major importance. The timber that has been tabulated as accessible is that which is: (1) coastal and can be harvested either through existing waterways, rail or highway access, or through minor

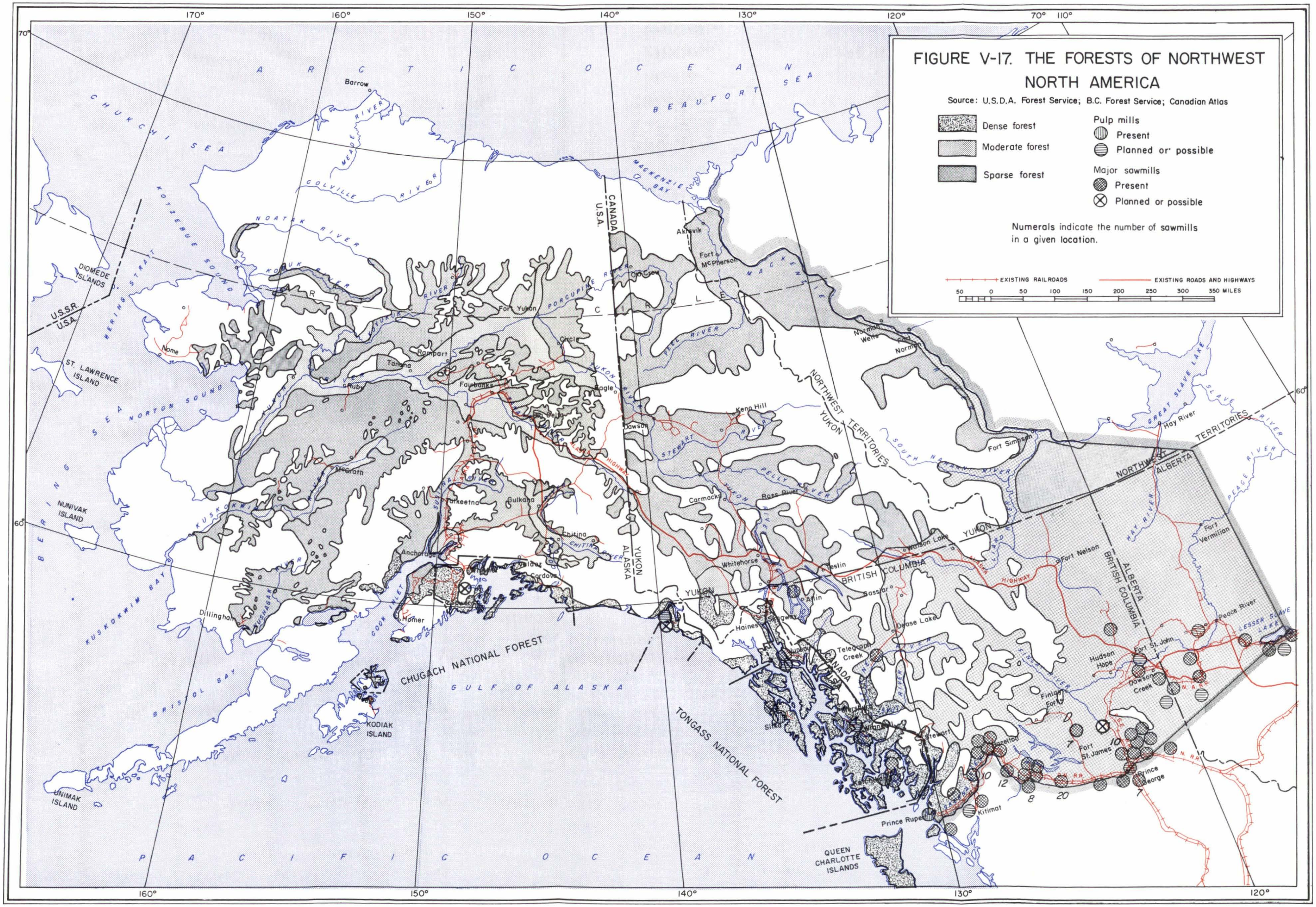
FIGURE V-17. THE FORESTS OF NORTHWEST NORTH AMERICA
Source: U.S.D.A. Forest Service; B.C. Forest Service; Canadian Atlas
Dense forest
Moderate forest
Sparse forest
Pulp mills
Present
Planned or possible
Major sawmills
Present
Planned or possible
Numerals indicate the number of sawmills in a given location.
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
PACIFIC OCEAN
GULF OF ALASKA
CHUGACH NATIONAL FOREST
TONGASS NATIONAL FOREST
KODIAK ISLAND
UNIMAK ISLAND
NUNIVAK ISLAND
ST. LAWRENCE ISLAND
DIOMEDE ISLANDS
QUEEN CHARLOTTE ISLANDS
U.S.S.R.
U.S.A.
CANADA
YUKON
ALASKA
BRITISH COLUMBIA
ALBERTA
NORTHWEST TERRITORIES
Barrow
Nome
Fairbanks
Anchorage
Fort Yukon
Dawson
Whitehorse
Juneau
Prince Rupert
Prince George
Kitimat
Fort Nelson
Fort Simpson
Hay River
Peace River
Dawson Creek
Fort St. John
Fort St. James
Aklavik
Fort McPherson
Norman Wells
Watson Lake
Dillingham
Homer
Valdez
Cordova
Sitka
Haines
Skagway
Atlin
Teslin
Carmacks
Ross River
Keno Hill
Tanana
Ruby
McGrath
Talkeetna
Gulkana
Chitina
Circle
Eagle
Rampart
Big Delta
Telegraph Creek
Dease Lake
Hudson Hope
Finlay Forks
Fort Vermilion
Hazelton
Stewart
ALASKA HIGHWAY
YUKON RIVER
MACKENZIE RIVER
PORCUPINE RIVER
PEEL RIVER
STEWART RIVER
PELLY RIVER
LIARD RIVER
PEACE RIVER
HAY RIVER
SLAVE RIVER
GREAT SLAVE LAKE
LESSER SLAVE LAKE
KUSKOKWIM RIVER
KOYUKUK RIVER
NOATAK RIVER
COLVILLE RIVER
MEADE RIVER
SUSITNA RIVER
CHITINA RIVER
NUSHAGAK RIVER
FINLAY RIVER
COOK INLET
BRISTOL BAY
KUSKOKWIM BAY
NORTON SOUND
KOTZEBUE SOUND
BERING STRAIT
MACKENZIE BAY
70°
60°
170°
160°
150°
140°
130°
120°
110°
10
12
8
20
7

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TABLE V-22. ESTIMATED FOREST RESOURCES OF NORTHWEST NORTH AMERICA

Area	Commercial Acreage, million acres			Volume, million fbm			Current Allowable Annual Cut[a], million fbm			Major Species	Quality
	Accessible	Potentially Accessible or Inaccessible	Total	Accessible	Potentially Accessible or Inaccessible	Total	Accessible	Potentially Accessible or Inaccessible	Total		
Alaska											
Coastal	4.3	1.9	6.2	106,600	69,900	176,500	1,060	500	1,560		
National Forest	3.5	1.9	5.4	100,100	69,900	170,000	1,000	500	1,500	Sitka spruce, western hemlock, Alaska and western red cedar	Overmature and mature, large trees; major part suitable for pulp only
Bureau of Land Management and others	0.8	-	0.8	6,500	-	6,500	60	-	60		
Interior	2.0	38.0	40.0	9,000	171,000	180,000	80	1,420	1,500	White spruce, white birch, aspen	Frequent burns generate young, growing stock
Total Alaska	6.3	39.9	46.2	115,600	240,900	356,500	1,140	1,920	3,060		
Canada											
Yukon	9.1	17.9	27.0	16,700	32,200	48,900	330	650	980	White spruce, lodgepole pine, white birch, aspen and balsam poplar	Mature, fair-sized large trees
Parts of Northwest Territories	-	<0.1	<0.1	-	500	500	-	10	10	White spruce, aspen poplar, black poplar	Clusters of good stands
Parts of Alberta	26.0	24.0	50.0	161,600	69,000	231,600	3,500	1,600	5,100	White spruce, lodgepole pine, white birch, poplar	Mature spruce, large quantity of growing stock in pine
Parts of British Columbia	58.4	6.3	64.7	594,000	58,000	652,000	7,200	650	7,850	Spruce, western hemlock, lodgepole pine	Mature forest, large trees, rapid regeneration on coast, immature and lower grade in interior
Total Canadian	93.5	48.2	141.7	772,300	159,700	933,000	11,030	2,910	13,940		
Total Northwest North America	99.8	88.1	187.9	887,900	400,600	1,289,500	12,170	4,830	17,000		

(a) Sustained-yield basis.

transportation improvement such as logging roads; (2) interior and is located on major river systems or tributaries that have present or readily created access for transportation to local consumption or processing points. Potentially accessible timber is considered dependent upon the construction of a complex of transportation systems not now in existence and of a major nature. Timber denoted inaccessible is considered as economically unreachable due to terrain by any now contemplated or practicably conceivable transportation, although of course, the development of new logging technology or greatly increased demand could reduce the inaccessible segment. For the most part, sufficient data do not exist to provide separate estimates for these latter two groups.

Most of the coastal forest is considered accessible, but some is not despite its location within a few miles of tidewater; the topography is often so difficult as to preclude the economical logging of the timber by conventional methods.

The accessibility of the interior forests is dependent upon making use of the major river systems and their adaptability to transportation either to local users, to local processing for eventual shipment out of the region, or to present or future processing facilities in established processing regions. Major rivers of the type discussed are the lower Mackenzie, the Liard, the Peace, the Tanana, the Copper, the Yukon, and others, together with their watersheds and feeder systems. Some of the densest and highest quality stands are located on or near these rivers, making easier the task of eventual logging.

Alaska

Alaska's forests are divided into two distinct classes, widely separated geographically. By far the more important currently is the "Coastal Forest", a northward extension of the forest type found along the coast of Oregon, Washington, and British Columbia, although this northward progression has resulted in the elimination of certain species prominent further south.

The "Interior Forest" is sharply differentiated from the Coastal Forest in species composition and stand volumes, reflecting the climatic and topographical environment. It is the westward extension of the forest pattern common to the Canadian Yukon and Northwest Territories in composition. Figure V-17 shows these forest regions; the extent and density of cover are apparent.

The Coastal Forest. The seaward slopes of the Coast and Chugach Mountain ranges are eminently suited for the continuous production of forest crops. Heavy rainfall combines with moderate temperature to produce a dense forest cover. On the coast itself, this cover is restricted to a narrow belt from 1 to 5 miles wide, except for penetration along the larger river drainages. In general, the islands of the region are well forested. The timber line on the coast and on the islands is at an elevation of about 2500 feet; most of the timber lies within 2-1/2 miles of tidewater. Within these limits are 16.5[1a] million acres classified as forest land. But of this, only about 25 per cent, or 4.3 million acres, is classified as commercially accessible.

Most of this productive land is publicly owned. About 3.5 million acres are in the National Forest system and an additional 785,000 acres are controlled by the Bureau of Land Management of the Department of the Interior. A further 20,000 acres are Indian land while somewhat less than this, or 19,000 acres, are held privately.(1b) Administratively, the National Forest of coastal Alaska is divided into two parts, the Tongass and the Chugach. Of the total land area in the Tongass (just over 16 million acres), 2.9 million are classed as commercially accessible forest, while an additional 1.6 million are currently inaccessible forest lands. The Chugach is a much smaller unit with a total land acreage of 4.7 million, of which 1/2 million are considered commercially accessible forest and an additional 1/4 million are currently inaccessible forest.(2)

The Coastal Forests generally are dense, with an average volume in the commercial segments of the National Forest of about 35,000 board feet per acre.(3) The total volume of standing timber in the National Forests is now estimated at 170 billion board feet(2); the National Forests, especially the Tongass (see Figure V-17), have by far the largest timber volume of the Alaskan coast. Of the 170 billion board feet in standing timber, 100 billion lie in areas now considered as accessible, while the remaining 70 billion are presently inaccessible. An estimate of the allowable cut, or that amount of timber which can (and should) be removed annually from the forest in order to optimize yield on a sustained basis, was made in January, 1959, based on incomplete data from forest inventories still in progress. These interim figures indicated that slightly in excess of 1 billion board feet are available annually for the wood-using industries.(1b) Were all the commercial forest land equally accessible, the allowable cut could probably increase by 50 per cent to about 1.5 billion board feet.

The Coastal Forest is coniferous, with hardwoods comprising less than 1 per cent of the whole. The hemlock - Sitka spruce species comprise almost all the coastal forest land, existing in mixed stands, with small admixtures of western red cedar and Alaska cedar. A typical stand would contain approximately 75 per cent hemlock, 20 per cent spruce, and 5 per cent cedars.(4)* All these species have at least some commercial value.

Western hemlock on maturity attains a diameter** of 3 to 4 feet, a height of 100 to 140 feet. Sound when young, hemlock rapidly develops rot and becomes subject to disease when mature; overmature trees are frequently so defective as to be unmerchantable. Commercially, it is satisfactory for saw timber, although it does not have the reputation of Douglas fir; it is an excellent wood for pulping and is widely used for this purpose, being preferred by the pulp mills at Sitka and Ketchikan.

Sitka spruce matures at 5 to 7 feet in diameter, 160 to 200 feet in height, although much larger specimens are frequent. Spruce is an excellent saw timber stock, preferred by Alaskan sawmills, and is generally thought of as the best pulping wood available.

The cedars are somewhat limited in volume to be a major factor in commercialization; further, defective trees, lack of reputation, and, in some cases, performance militate against commercial enthusiasm for these woods.

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*Actual cutting experience of the Ketchikan Pulp Company indicates closer to 8 per cent of cedar, an undesirable species for pulping.

In the commercial parts of the Tongass National Forest, western hemlock makes up 64 per cent of the volume, Sitka spruce 29 per cent, with the balance in cedars.(3)

**Diameter breast height (d.b.h.).

Over-all, the quality of the Coastal Forests is considered good, but not excellent. The forest contains a high proportion of overmature trees which are defective and unmerchantable. While the greater part of the forest is of saw timber size[1c], only about 20 per cent is in growing stock, the important part of the forest for growth and reproduction purposes. The balance is in mature and overmature trees; additional volume exists in salvable dead trees. Further, the yield of high-quality lumber from even the better logs is relatively low, making it difficult to obtain a concentrated output of prime saw timber. For these reasons, about 90 per cent of the forest is considered presently better suited to the pulp and wood-fiber industries, although, of course, some saw timber utilization is feasible.

The forest-management plans of the area are designed to maximize the allowable cut without interfering with – indeed abetting – the natural reproduction of the forest.[5] Detailed cutting schedules are based on close study of the forest areas and the species pattern of growth and development. The management objectives are sustained yield, stable economic development and growth, utilization of minor species, and satisfactory integration with other uses of the forest, such as watersheds, recreation, wildlife preserves, and others. A bonus benefit of good forest-management planning is that yield will not only be sustained in the present, but eventually sharply increased. As the overmature and dead stock is removed by clear cutting of selected strips, second-growth stock of desirable species, naturally reseeded, will provide increasing yields per acre.

<u>The Interior Forest</u>. The Interior Forest comprises a vast sweep of partially wooded areas which extend northward from the coastal mountains to the Arctic tundra. Bounded by the Canadian border on the east, the Brooks Range on the north, and the heads of Norton Sound and Bristol Bay on the west, subject to semi-arid conditions of rainfall and wide swings in temperature between the hot summers and cold winters, the interior forest is sparse except along the river drainage systems. The timber line varies between 2000 and 3000 feet in altitude. In total, the Interior Forest encompasses about 120 million acres, of which 40 million acres have dense enough cover to be classed commercial.[6a] Very little of this is presently considered accessible.

Even though classed commercial, the density of the Interior Forest is but a fraction of the Coastal Forest. The heavier-forested regions following such streams as the Copper River and its major tributaries, the Matanuska and the Susitna Rivers, upper Cook Inlet, Iliamna Lake, Lake Clark, and the Kuskokwim, Tenana, Nushagak, and Yukon Rivers, average about 4,500 board feet per acre, although individual mature sites may exceed 15,000 board feet per acre.[7] While no inventory has been made (although one is underway), available estimates indicate a total volume of about 180 billion board feet, or approximately the amount in the smaller but denser Coastal Forest. The net growth of this forest is greatly retarded by fire, insects, and disease, but has been calculated at a possible 3.9 billion board feet per year. While the allowable cut would fall greatly short of this at first, operations under a thorough forest-management plan would tend to approach this goal through the years. A conservative estimate of the allowable annual cut presently is 1.5 billion board feet.[6b]

Present distribution, stand composition, density, and volume of the Interior Forest is largely a product of past fires.[1d] The complex pattern now existing derives from a history of fire that has burned over 80 per cent of the forest, or an average of 1 million acres a year since 1940.[6c] Recent efforts have been successful in sharply reducing the annual burn.

Unlike the coniferous Coastal Forest, the Interior Forest has significant quantities of hardwoods. A rough estimate(1d) is that 29 million acres of the commercial forest land are softwoods, 11 million acres hardwoods. In terms of area, softwoods dominate in providing 55 per cent of the ground cover, while hardwoods cover 19 per cent of the area, leaving 26 per cent with a mixed cover composed of 60 per cent softwoods and 40 per cent hardwoods.(1d)

White spruce is the most important species in the interior, from the standpoint of geographic distribution and potential economic importance. These trees reach heights of 80 to 100 feet and diameters of over 2 feet. The species is suitable for saw timber or pulpwood. White birch, another major species, may reach 80 feet in height and 18 to 20 inches in diameter. This birch is suitable for saw timber, veneer, and manufactured products, as well as pulp. Other species include quaking aspen, possibly suited for pulp, and dwarf black spruce, balsam, willows, poplar, and tamarack; none of the latter are of immediate commercial value.

The present inaccessibility of the Interior Forest, and the ability to satisfy demand to date for forest products from sources nearer at hand, may account for the lack of detailed information about the quality of the forest. The stands generally are presumed to be young, in various stages of recovery from fire. Rates of growth, yield, and location of the best stands all await study. Such study is just beginning; less than 1 per cent of the forest has been inventoried.(8) At this time, the major concern is fire control, to preserve the resource until it is developed.

Canada

The forest cover of Canada, comprising more than two-fifths of the land area of the Dominion exclusive of Labrador, extends from the southern border to the edge of the tundra. As a whole, these forests are subject to a wide variety of conditions of temperature, drainage, and rainfall. Predominantly they are coniferous with some admixture (17 per cent) of hardwoods.(9a) These vast resources, mostly publicly owned, have provided the basis for the emergence of Canada as a major factor among forest-product-producing countries of the world. Most of the dense, productive forest lands are in the Maritime Provinces, Quebec, Ontario, and British Columbia, in the more southerly reaches of the Dominion. Of the regions of Canada with productive forest land, those under study here are the Yukon and parts of British Columbia, Alberta, and the Northwest Territories.

Yukon Territory. All of the Yukon falls within the geographic scope of this study. This area is a part of the Boreal Forest, by far the largest forest complex of Canada, stretching from the Atlantic Ocean to Alaska. The climate and topography correspond closely to that of interior Alaska, described above.

Of the 52 million acres of forested land, 27 million are considered commercially productive.(9b) Present access exists to 9.1 million acres, while the balance of 17.9 million acres is considered potentially accessible, with no inherent barrier. Not all of this area supports merchantable timber stands. An early estimate was that about 10 per cent of the commercially forested land supports timber in a merchantable volume of 5000 board feet or more per acre.(10a) A later report estimates that the volume of merchantable timber in the accessible part of the Yukon is 16,700 million board feet*, of which 13,900 million are softwoods and 2,800 million are hardwoods.[11] Volume in the area considered potentially accessible is estimated at 26,100 million board feet of softwoods, 6,100 million of hardwoods, for a total of 32,200 million. The Yukon total would then be 48,900 million board feet, of which 40,000 million are softwoods, 8,900 million are hardwoods.

On the basis of the above standing volume, the allowable cut on the accessible part of the forest is about 330 million board feet; that of the potentially accessible forest is 650 million board feet. If all of the forest were equally accessible, some 980 million board feet, primarily softwood, could be removed annually.[9c] These figures are considerably in excess of earlier estimates.

Most of the forest wealth of the Yukon is concentrated in the southerly portion. Precipitation is somewhat heavier in the east than in the west, and this is reflected in the pattern of forest growth. With a generally low elevation and southerly location, the Liard watershed is said to contain the best timber in the Yukon. Large stands of spruce occur, at times containing over 30,000 board feet per acre.[10b] Further, the general growth rate is such as to allow a commercially promising rate of cut. The predominant species is white spruce, suitable for saw timber and fuelwood and excellent for pulping. Lodgepole pine, balsam poplar, aspen poplar, and white birch are of sufficient size and quantity to be of potential commercial interest. Black spruce is common but of no commercial interest.

Northwest Territories. Only the area west of the Mackenzie generally, and west of a line drawn through Kakisa and Tathlina Lakes to Alberta, falls within the scope of this study. Very little of this land contains commercially significant forest. Most of the forest lands extending along the Mackenzie to Beaufort Sea are sparse Boreal type. In all the Mackenzie District, only two localities have strips or patches of sufficient frequency and density to be merchantable, and but one of these localities lies wholly within the area under consideration. This is the lower Liard Valley, from Nelson Forks to Fort Simpson; most of this valley lies north of the British Columbia border within the Mackenzie district. This area is the only substantial source of timber for the lower Mackenzie basin. Spruce, aspen, and black poplar occur in sizable blocks in the heavily wooded lower Liard.

Another fairly sizable volume of timber lies along the Mackenzie River between Great Slave Lake and Norman Wells. This is estimated at 206 million board feet of white spruce in merchantable timber.[12]

Only scanty and older data are available for the Northwest Territories[10], but some estimates can be made. The forest section of Alberta which is contiguous to the portion of the Mackenzie district that is part of this study, and is of about the same forest type, density, and size, contains a volume of 643 million board feet. A contiguous section of British Columbia of similar area and characteristics contains 506 million board feet. Therefore, it appears conservative to assume a total of 500 million board feet for the Northwest Territories that are part of this study. Perhaps 400 million

*Much of the Canadian data, including that found in Reference (9b), is presented in cubic feet of volume. The conversion of a cubic foot measure of volume to board feet requires consideration of variables such as species, bark thickness, diameter (d.b.h.), and others. There is no generally accepted factor, measures running from about 4 to over 6 board feet per cubic foot. In the light of the information available, and in place of a detailed analysis, the figure of 5.5 board feet per cubic foot was selected as a reasonable compromise, and has been used before in published Canadian and U. S. literature.

of this is softwood, 100 million hardwood. The annual allowable cut is estimated at under 10 million board feet. *

Alberta. The northwest quarter of Alberta is included in the forests of Northwest North America under review. Most of this area is well-covered Boreal Forest containing, in fact, about three-quarters of Alberta's forest resource.[13] Broadly, about 50 million acres of Alberta's 68.4 million acres[9b] of commercially productive forest lie within the area under study. Of this, somewhat more than half, or 26 million acres, is considered accessible.

Hardwoods are much more of a factor in Alberta than in other woodlands of Northwest North America, amounting to about two-fifths of the whole. In the accessible forest under study, for example, there is a volume of about 162,000 million board feet, of which 93,000 million are softwoods, 69,000 million are hardwood. The potentially accessible forest contains an additional 69,000 million board feet in a roughly equal amount of hard and softwood. The allowable cut, a measure of the size and potential significance of Alberta's accessible forest reserves, amounts to 3500 million board feet annually — 1900 million softwoods, 1600 million hardwoods. Similar cuts from the potentially accessible woods add 1600 million board feet, for a total exceeding 5100 million board feet.[9b]

An inventory of Alberta forest resources is in progress which will provide specific data for future planning.[14] Fire control, as well as disease and insect damage, remains a serious problem, one on which the weight of available skill and equipment is constantly being brought to bear. A lack of large quantities of sawlog-size pine has centered emphasis on spruce, of which there are sufficient trees 12 inches in diameter and larger. However, there is an enormous reserve of pine between 4 to 10 inches in diameter, while there is less than half as much spruce of this size. This indicates that cutting will have to switch to sawlog-size pine in the future, because of the relative plenty of this wood and the growing scarcity of growing stock in spruce. The forests that have been inventoried at this writing show characteristics of good quality; the species - spruce, pine, poplar and birch - are all commercially desirable. Generally, the woods are immature, rather than mature or overmature; proper management is being applied to balance the forest. Were heavier proportions of timber in overmature and mature trees, not only would yield be significantly less, but clear cutting of large areas would be required to provide opportunity for higher yield, better quality second growth.

British Columbia. The woodlands of British Columbia, covering 60 per cent of the land area, are its prime asset in terms of actual and potential resources.[15]** British Columbia's total 158 million acres of forest land contain 110 million acres considered commercially productive according to latest estimates.

Included in this study is the area lying north of the Canadian National Railway line to Prince Rupert, containing over 60 million acres of forest, of which 90 per cent is considered presently accessible. Besides the Boreal Forest type common to the other areas of Canada, in this region also lie: sub-Alpine Forest regions of Engelmann spruce, alpine fir, white-barked pine, and some aspen and hemlock; Montane Forest with Douglas fir, alpine fir, and lodgepole pine; and some of the dense Coastal Forest

*Battelle estimates using relationships utilized in Alberta and British Columbia.

**One-quarter of Canada's forest land, one-third of the cubic-foot volume.

with its Sitka spruce, western and mountain hemlock, cedar, and other species. The heavy coastal precipitation and mild temperatures of this last region are, of course, productive of the same type of forest as that of coastal Alaska discussed above and separated by political, not biotic considerations. The Boreal Forest is like that of interior Alaska in species composition, minimal rainfall, and relatively severe temperature variation.(9)

Much of the land being considered is of the Interior Forest type, contains smaller trees, and is less dense than the Coastal Forest. Hardwood species are several times as common in the interior as on the coast, but in either case the volume is small and relatively insignificant. The volume of accessible merchantable timber in this section of British Columbia is estimated at 594 billion board feet,(16) of which 585 billion is softwood, 9 billion hardwood.

The quality of the British Columbia forests is considered high, with a very large proportion (73 per cent)(17) in mature timber. Desirable species comprise about 60 per cent of the total. While the Interior Forest contains more immature and lower grade timber, much of it is suitable for smaller sawlogs and pulpwood. Forest-management plans are devoted to bringing the coastal and interior woodlands under sustained yield programs, which should significantly increase the yield. The currently allowable cut is estimated at 7 billion board feet from the accessible portion(18a), a figure which could be significantly increased when the less accessible regions are tapped.

Past and Present Utilization of the Forest Resource

Before 1954, the conversion of the timber resources of Northwest North America was scanty and minimal in terms of the quantity and quality of supply available and in relation to the giant woods industries of the southern portion of the Canadian provinces. Local production most frequently was of such small scale that it did not satisfy local needs and was dwarfed by the imports of timber products to meet local demand. This occurred simultaneously with the export of certain timber products from the region.

To a certain degree, this picture started to change with the installation of two large dissolving-pulp mills in Southeastern Alaska. These provided for the first time for the local processing of a significant proportion of the available timber and opened the vista of a major woods industry in the entire region.

Alaska

The total value of the forest industries in Alaska, including rough and finish sawmilling, pulp and manufactured products, amounted to $27.3 million in 1958, of which $22 million or 80 per cent was pulp. This was down somewhat from 1957's peak of $33.1 million but sharply up from the pre-pulp mill era average of about $4.5 million in 1950-1953.

The harvest for the most recent fiscal year, ending June 30, 1960, is estimated at well over 400 million board feet, of which 350 to 400 million derive from the National Forest.(19)

Lumber. Sawmilling is one of the oldest industries in Alaska, dating from the Russian era. Sawmill production rose as shown in Table V-23.

TABLE V-23. TIMBER CUT IN ALASKA 1899-1958[a]

Year	Number of Sawmills	Total Timber Cut, million board feet
1899	10	6.6
1919	22	21.7
1929	19	30.4
1939	24	25.9
1945	35	59.1
1949-1953 avg	55 (est)[b]	86.0[c]
1954-1958 avg	95 (est)[b]	192.2 (including pulp mill)

(a) Source: "Alaska: Our Rivers: Total Use for Greater Wealth", 82nd Congress, First Session, House Document 197, U. S. Department of the Interior, Bureau of Reclamation (January, 1952).

(b) Rogers, George W., Alaska in Transition, Johns Hopkins Press (1960).

(c) Cut in 1952, "Timber Resources for America's Future", Forest Service, U. S. Department of Agriculture, Forest Resource Report No. 14 (January, 1958), Table 103.

By 1946, there were 7 sawmills with a capacity of 20,000 board feet per shift or greater, as well as 25 smaller mills in the coastal region. In addition, there were 4 shingle mills, and 5 box plants making shipping containers for the fish catch.[20] Enterprises increased rapidly so that by 1954 some 55 firms, other than one-man operations, were engaged in the lumber trade, but of these only 1 employed more than 100 persons, 2 employed from 20 to 99 persons, and the rest were quite small.[21] But the total installed capacity was less than 8 per cent of the then calculated sustained yield;[22] the low rate of production indicated that less than 3 per cent of the allowable cut was utilized.

By early 1960, there were 6 sawmills with a capacity of 50,000 board feet per shift or greater, including 2 fairly large installations at Wrangell, one of which began production in May of that year. The plant of the Alaska-Wrangell Mill, Inc., alone produced about 20 million board feet in 1959. In addition, there are more than 70 small portable mills, mostly in interior Alaska, supplying the localities about them with sawn timber. A plywood mill was installed in 1953, but this was destroyed in a fire during 1959, and no plans are known for immediate rebuilding.

A new wood-treating plant for pressure treatment of poles, piling, posts, etc., is being constructed at Whittier by the Koppers Company. Plant capacity is 5 million board feet, and the timber input, mostly hemlock, will be derived from the Chugach. Local pressure treating should satisfy some of the demand for which, in 1957, over 17,000 tons of posts, poles, piling, and ties were imported.

Pulp Mills. It has long been recognized that Southeastern Alaska offers excellent opportunities for pulp mills, especially in the timber-rich Tongass. Many individuals, agencies, and private groups studied and restudied the economic feasibility of pulping operations in the area. But no positive action was taken between 1920 and 1950 while lower British Columbia was being extensively developed.

The first concrete step toward the creation of an Alaskan pulp industry was taken with the opening in 1954 of the Ketchikan pulp mill, culminating more than 7 years' development by Puget Sound Pulp and Timber Company, later joined by American Viscose Corporation. The Ketchikan Pulp Company produces dissolving pulp used for rayon, cellophane, and other varied purposes, most of which is taken by one of the parent companies, American Viscose. The mill has a capacity of 600 tons per day, but has only recently reached this level after several years spent in "shaking down" the new facility. Sales of the pulp by Ketchikan amounted to $21.9 million in 1958 and $29.9 million in 1959.

Encouraged by the profitable operation of Ketchikan Pulp Company and pressed by a shortage of timber for quality dissolving-pulp manufacture at home, Japanese interests merged under the corporate organization of the Alaska Lumber and Pulp Company, took over operation of a sawmill at Wrangell and established a dissolving-pulp mill at Sitka. This pulp mill went on stream late in 1959. Effective capacity is rated at 450 tons per day, considerably over the nominal design capacity of 340 tons per day, and the production is destined for the Japanese market.

Other pulp-mill possibilities are pending. Pacific Northern Timber Company and Georgia-Pacific Company (through its subsidiary, Georgia-Pacific Alaska Company) have contracts for cutting rights to Federal timber in the Tongass. These must be utilized before contractual deadlines – July 1, 1961 for Georgia-Pacific and 1965 for Pacific Northern.

Currently, some 24 billion board feet are contracted in large, long-term National Forest timber sales: Ketchikan Pulp Company has 8-1/4 billion; Alaska Lumber and Pulp, 5-1/4 billion; Pacific Northern Timber, 3 billion; and Georgia-Pacific Alaska, 7-1/2 billion board feet. These mills, once all are in production, would annually cut 700 million board feet out of an available allowed annual cut of 1 billion board feet on a sustained yield basis.[(6)] In total, perhaps 70 per cent of the accessible timber in the National Forests, according to the most recent studies, is thus accounted for. No additional contracts will be let for pulp-mill use until experience has shown that the already existing and planned mills have an assured supply of wood for present needs and future increases in capacity.

Canada

The situation in the Canadian provinces considered as part of the Northwest North America region does not rest so much upon the initiation and development of a forest-industry complex, as in Alaska, but upon the extension northward of an already well-developed industry existing in the southerly regions. Much has already been done, especially in British Columbia and Alberta, to utilize the woods resources available. More is planned as the logical sequence to present and past activity. The available timber, especially that of western Alberta and British Columbia, is considered and treated as a valuable resource, partially but significantly utilized to date.

Alberta. Within the geographic limits of the Province included in this study, roughly equivalent to Alberta Census District 15, there were, as of 1957, upwards of 99 sawmills, of which 6 had an annual capacity of 5 to 10 million board feet; 13 had an annual capacity of 2 to 5 million board feet; and about 80 were relatively small, rated under 2 million board feet.(23) There were also 9 sash, door, and planing mills and 3 furniture plants in the area. Some 3000(24) persons were engaged in forestry and logging operations to supply local manufacturing plants as well as plants, including the pulp mill, to the south. In addition, there is a plywood mill at Grande Prairie; another is being developed for Fort Fitzgerald, just outside the area limits.

Of the 336 million board feet cut in Alberta in 1957, 178 million were produced in Census District 15.(24) One of the three major firms in this area produces about 25 million board feet annually. The current annual out of the Province represents only about 15 per cent of Alberta's over-all potential yield; the cut can be increased by a factor of 6 to 7, assuming that the forests can renew themselves to the same composition and acreage. In the part of Alberta included in this study, somewhat adverse conditions of soil and climate indicate that more of the potential yield is being utilized, about 25 per cent, but still eventual utilization could quadruple that of the present.(25)

Prior to the opening of Alberta's pulp mill, about 60 per cent of the value of the Province's wood-products industry was exported, primarily to the U. S. With the manufacture of pulp, the percentage of exported forest products should rise significantly. However, it is unlikely that the same ratio holds for the sector of Alberta under study, which does not have a pulp mill. Production from the larger sawmills is frequently shipped as far as New York, but that from the smaller mills is more often consumed locally. Even so, local production of consumer goods does not satisfy provincial demand. For example, in the year in which Alberta produced almost $6 million worth of furniture, another $12 million worth was imported.

Yukon and Northwest Territories. The past and present production of forest products in these areas is minimal indeed, in terms of local consumption or potential timber. No planing mills, furniture plants, other wood-using plants, or pulp or paper mills are present in these more remote regions. Sawmilling is the only activity pursued in the timber field, and this is quite small scale.

In the part of the Northwest Territories under study there are 2 sawmills at Fort Norman and Fort Simpson. There are 4 more nearby, but outside the arbitrary bounds of the study; these are on feeder streams to Great Slave Lake.

The Yukon is better represented with 46 sawmills – 16 at or around Whitehorse, 27 near Keno Hill, 2 in the Teslin area, and 1 near the southern part of the Alaskan border line. None of the Yukon or Northwest Territories mills exceed 2 million board feet annual capacity, while actual production is considerably less than capacity.

In terms of the share of available timber now being utilized, it appears likely that less than a tenth is so used in the Northwest Territories, while probably much less than this is being used of the accessible Yukon timber, perhaps less than 2 per cent of what could be harvested on a sustained annual-yield basis. Apparently, none of this material is exported, all of it being consumed locally.(26)

British Columbia. The forest reserves and forest industries of British Columbia have been a major factor in Canada's present position of dominance as a producer of lumber, pulp, and paper products for export. Most of this industry is concentrated in the southern region of the province, but a significant production lies above the Prince Rupert-Prince George line.

There is no exact correspondence between the part of British Columbia included in "Northwest North America" and the administrative districts by which the province's forests are managed. However, two forest districts - Prince Rupert and Prince George - include all the northern part of the province as well as a small section in the southeast extending south of the arbitrary line defining Northwest North America for the purposes of this study. In 1958 the timber cut in these two forest districts amounted to 1,139 million board feet, down somewhat from the average of the previous years.[27a] This was 21.3 per cent of the British Columbia total in 1958. It also represents about 15 per cent of the accessible allowable annual cut for the part of British Columbia in Northwest North America. In 1959, production of pulp and timber from the British Columbia interior forests exceeded the production of the Coastal Forests for the first time.

The relative position of British Columbia versus all of Canada is presented in Table V-24 for 1957. It is noteworthy that almost two-thirds of the Canadian lumber and plywood industry and over one-third of the logging industry derive from British Columbia. While the last few years have seen a decline in lumber production, this is increasingly offset by increased production of pulp and paper, plywood, and other items.

TABLE V-24. NET VALUE OF PRODUCTION OF FOREST INDUSTRIES, CANADA AND BRITISH COLUMBIA, 1957[a]

	Net Value of Production, millions of dollars		
	Canada	British Columbia	British Columbia as Per Cent of Canada
Logging Industry	733.1	263.4	35.9
Lumber Industry	237.7	147.2	61.8
Pulp and Paper Industry	693.5	87.9	12.7
Plywood Industry	53.6	33.9	63.3
Miscellaneous Forest Industries	479.0	49.7	10.4
Total All Forest Industries	2,196.9	582.1	26.5

(a) Source: Bureau of Economics and Statistics, Victoria British Columbia, communication to Battelle (April 12, 1960).

Table V-25 presents information on sawmilling in the province. In 1958, sawmills in Prince Rupert and Prince George Forest Districts represented almost half the total number, but only a third of the total capacity.

In addition to the operating sawmills, in 1958 there were 586 establishments with a capacity of 4,007,000 board feet shut down. Of these more than half were in the portion of British Columbia under study - 286 establishments with a capacity of 1,880,000 board feet.[28]

TABLE V-25. SAWMILLS OF BRITISH COLUMBIA IN OPERATION, 1958[a]

Forest District	Number of Sawmills	Estimated 8-Hour Capacity, thousand board feet
Prince Rupert 1958	273	1,746
Prince George 1958	669	7,368
	942	9,114
Total, 1958	2,010	27,649
1957	2,255	26,752
1956	2,435	29,080
1955	2,489	28,016
1954	2,346	25,602
1953	2,413	23,300
1952	2,223	23,433
1951	2,100	21,748
1950	1,826	19,143
1949	1,671	19,082

(a) Source: "Report of the Forest Service", Province of British Columbia, Department of Lands and Forests (1958), p 101.

It is interesting to note that the average size of sawmill has steadily increased, for while 1958 saw a regression in the number of operating mills since 1951, the capacity of the remaining mills became 25 per cent greater.

The mills in Prince Rupert and Prince George districts are generally smaller than those in the coastal Vancouver district, for example. There are but 12 of middle to large size, about 115 small size, and an additional 800 plus mills which are part-time, portable, and generally of minor significance, as shown in the following tabulation of 1954 data:(29)

Number of Sawmills	Location	Capacity, board feet per 8-hour shift, per Plant
1	Prince George area	150,000
3	Prince George area	50-100,000
7	Prince George area	25-50,000
1	Fort St. John area	25-50,000
117	Scattered	10-25,000
About 800	Scattered	Under 10,000

There also were, in 1954, 34 sash, door, and planing mills, 2 furniture plants, and 1 pulp mill in the north. This pulp mill, located at Prince Rupert, had a nominal capacity of 300 tons a day of sulfite pulp and employed some 1300 persons in forestry and logging.

On balance, while the north of the province is not nearly so well developed as the southerly regions, a sizable forest-products industry exists supplying local needs and export.

Current and Potential Demand

As with most basic materials, a complete compilation of all the uses for the various species of wood would be burdensome and meaningless. The composition of the available resource imposes certain limitations on possible or feasible end uses. Further, certain factors affect demand for timber products independent of their availability. To be considered are such factors as population and the consequent demand for residential housing, newsprint, packaging materials, and others; the state of business health and activity as reflected in nonresidential construction and the use of shipping materials; the relative and absolute price level of timber and timber products versus other materials such as plastics; and technological improvements or changes which create competitive materials or affect the end uses for timber.

Determination of the effect and interrelationships of these and other equally important considerations have been made by several agencies in order to project the future demand for broad classes of forest products. Such information has been reviewed and evaluated for use here. In this study, the output of the forest industries has been divided into two areas – wood as such, including:

(1) Posts, poles, and pilings

(2) Lumber, used in construction, manufactured products, and shipping (containers, pallets and dunnage)

(3) Veneer and plywood

(4) Particle board

(5) Fuelwood

and pulp products, including:

(1) Dissolving and paper-grade market pulp

(2) Newsprint

(3) Other paper and paperboard, except building board, such as hardboard and insulation board.

There are a variety of miscellaneous waste and by-products possible, such as tall oil, chemicals from wood, and others, but these are not suitable for the species involved, are no longer economically feasible, or are wholly dependent on other primary manufacturing installations.

To correlate the market potential for forest products with the available resource, three categories of demand and supply have been considered. These are regional, including the local demand of the various segments of the area under study for their local product or for the production of other parts of the area; North America, including the balance of Canada and all the continental U. S.; and export, including that portion of the world market which may be accessible to timber production from Northwest North America. The export market is limited, in Battelle's judgment, to countries bordering the Pacific, plus all of South America. Even from these must be excluded mainland China and Siberian Russia on political, if not economic grounds. The balance of the world market, primarily Europe and Africa, is affected by factors such as extreme distance or huge potential supply coupled with minimal present consumption, as in the case with Africa. Further, if a demand for the products of Northwest North America cannot be reasonably established in the three geographic regions cited, it appears tenuous in the extreme to rely on other world markets to provide a sound basis for the development of the forest industry.

Regional Demand and Supply

Internal consumption within the region of Northwest North America should not account for more than a minimal amount of potential production by 1980. However, it is certainly reasonable to assume that the region can supply itself with many of the lumber products it now imports.

Wood and Wood Products. The wide fluctuation in past consumption makes it difficult to estimate an average figure for a current year. However, on the basis of 1957 data for Alaska, approximately 60 million board feet of timber were produced and consumed locally. In addition, some 70,000 tons of wood products were imported from the States.[30] Considering the various forms and densities of wood involved, this tonnage is estimated as roughly the equivalent of 40 million board feet. This indicates a total Alaskan market for 100 million board feet of wood and wood products for 1957.

To this must be added the consumption of the Canadian portion of Northwest North America. With a population of 66,000 persons in 1950, perhaps 100,000 maximum in 1957, and without either the military activity of Alaska and the consequent economic impetus to that state, it seems unlikely that this consumption amounted to more than 25 to 50 per cent of Alaskan consumption. Total regional consumption is estimated at 125 to 150 million board feet of wood and wood products.

Certainly regional demand will increase with growth in population and economic activity. What such growth will be is in the nature of speculation rather than prediction at this time; growth may be dependent in part on forest-product manufacture which in turn will depend to some extent on growth in population.

An estimate has been made[31] that the population of Alaska will exceed 1 million by 1980. This assumes a fourfold growth which, even if exaggerated, could reasonably be considered a "maximum".

Even such a possible rise in regional demand will strain neither available wood supply nor conversion capacity. The present and potential annual allowable cuts on a sustained yield basis far exceed any rationally projected demand. Conversion capacity in terms of rough sawmilling is under-utilized now and can readily meet this level of demand by fuller utilization, by the addition of portable facilities, or by the construction of some larger sawmills. None of these is beyond the capability of the regional wood industry.

However, this broad generalization does not hold for each specific segment of the total demand. For example, much of the wood imported into Alaska was in the form of treated posts, poles, and pilings. These could not be locally produced until the installation of a pressure-treating plant became a reality. Other imports include plywood, so that the recently destroyed plywood mill must be replaced if this market is to be garnered locally. Still another important market segment is furniture, and here only a fraction can ever be obtained by local producers. Considerations of style, wood species or other material, brand name, cost of manufacture, and the like will always influence some buyers to prefer imported furniture to that of local manufacture.

Another important point is the quality of regional production; this reflects partly on the available species but primarily on the producer's control of quality. If local markets are to be satisfied in large part by local production, except for rough lumber, shipping lumber, and similar products, then Alaska (and other regional) producers must build and maintain a reputation for consistent quality. Certain of the native species (Sitka spruce, birch, cedar) appear to compare favorably with their continental U. S. cousins in quality of wood. Only close control of production can exploit and retain this advantage.

Pulp Products. In the foreseeable future, regional demand for pulp and pulp products is not likely to include demand for dissolving and/or paper-grade market pulp. Dissolving pulp is a product of the region now, with two active mills in Southeastern Alaska. It is shipped to well-established chemical plants in Japan or the eastern U. S. for conversion to rayon, cellophane, or other cellulosic derivatives. Since present world capacity is more than adequate to take care of demand and since the economics of end-product manufacture usually dictate locations close to the ultimate consumer, there is little if any likelihood of the establishment of chemical plants using dissolving pulp in this area.

Much the same reasoning holds for paper-grade market pulp. Today's mills are usually integrated from the forest to the end product – paper or paperboard. New mills to be established in the region should also be fully integrated. While there may be some tonnage trading eventually among the regional mills to fill out gaps in quantity or type of pulp temporarily short, this cannot be considered a market in the true sense of the word.

Newsprint consumption in Alaska is about 900 tons per year. There is a close correlation between newsprint consumption and population, at least when a certain cultural setting and level of economic activity (disposable income) are assumed. Therefore, the relationship that was suggested above between present and potential consumption in Alaska and the remainder of the Northwest North American region under study can be presumed to hold. Adding 25 to 50 per cent to the Alaskan consumption indicates a present consumption throughout the region of 1175 to 1350 tons of newsprint. If the population rises to the density noted above, which appears to be a decidedly optimistic view and thus may be considered an effective maximum, a future consumption of four to five times that of the present may develop. This would be roughly 5500 tons of newsprint per year.

Modern newsprint mills are among the most efficient and awesome plants built. A production of 500 tons per day per mill (one machine) is almost minimal, while outputs of 1000 or more tons per day are common. Thus the demand of the entire region predicated on an optimistic approach could be satisfied with the output of a modern mill for 1 week. Therefore, regional demand will not form a sound basis for the establishment of a new mill, although such demand would undoubtedly be supplied from a new mill in a favorable location that looked outside the region for its customers.

There is no shortage of newsprint in the vicinity. Alberta's first newsprint mill is under study (Alberta West Forest Products Corp., Ltd., location undecided at this time), while British Columbia already has three mills which make newsprint, with a combined capacity in excess of 2000 tons per day, plus capacity for making pulp and other paper and board products. Also, at least one Alaskan newsprint mill (Georgia-Pacific Alaska Co.) is being considered.

The classification of "other paper and board" includes a huge miscellany of primary and converted products, such as corrugated boxes and the liner and corrugating medium to make them; folding and set-up boxes of various kinds and the bending board to make them; book paper of various grades; white paper such as fine paper and writing papers; tissue, toweling, and a host of others. Only the markets for primary paper and board can be considered within the limited scope of this study. However, this primary manufacture may be converted into industrial and consumer goods either in the region or before shipment into the region.

There is no good basis for reliable estimates of the total quantity of paper and board consumed in one form or another in the region. At least 20,000 tons of such products were shipped into Alaska alone in 1957.[30] Comparisons made with per capita consumption of paper and board in the continental U. S., when newsprint and building board are excluded, indicate that Alaska's 1958 total consumption could have been on the order of 37,000 tons. It was probably somewhat less because of the presence of native and military population and the absence of industrialization, so that a reasonable compromise is a consumption on the order of 25,000 tons per year. Enlarging this on the same basis as above to include all the region generates a possible consumption of 32,000 to 38,000 tons per year, rising to a maximum by 1980 of perhaps 150,000 tons annually.

The sheer diversity of product included in these gross figures precludes a mill which is based on regional consumption of printing papers, or tissue, or board. Such a mill would have to rely primarily on sales outside the region. Further, as with newsprint, there exist mills in nearby sections of British Columbia which can furnish many of the needed products, at least where tariffs are not a factor.

There appears to be more opportunity for converting plants of one kind or another. While no detail of this sort can be considered extensively, it may be noted that, for Alaska at least, projected population and business indicators appear to permit of the establishment of board converting plants. Perhaps one corrugator or sheet plant, and one or two folding-box plants could be established to package the products of the local industry that must be generated to fulfill economic predictions and expectations. At this time most of such Alaskan needs are imported from the States to avoid a tariff barrier, although two corrugated plants and five folding-box plants are established in British Columbia and one of the latter in Alberta.

Building board is the last category considered and normally includes hardboard and insulation board. Particle board caused some concern as to its proper classification when it first appeared on the market, but is now held to be a timber rather than a fibrous product. Local consumption of the new material is probably minimal since its primary use is in the manufacture of flush doors, furniture, and similar products and there is little of these in the region. Even a small particle-board mill could not sell a major part of its output in the region either currently or on the basis of future projections.

Hardboard is used in manufacturing, but this is not likely to be an important factor here. For example, automobile manufacturing takes significant quantities. Furniture and other manufactures do use hardboard, and local industries, albeit small, would consume some. Hardboard also generally enters into construction while this is the sole important outlet for insulation board. Therefore, residential and nonresidential construction will for the most part determine whether the regional market alone would justify a plant for one or both of these materials; they are frequently made in the same plant since much the same equipment is required for manufacture.

As in any pulp and fabrication operation, efficiency of plant and economy of operating costs are definitely functions of size. Capital investment on a per ton basis and operating costs per unit output drop sharply with increasing size until a critical economic minimum installation is reached, and then tend to level out. Still larger plants have some, but not such a great, proportionate advantage. This minimum economic size is about 30,000 tons per year for each product; more than this, or about 40,000 to 50,000 tons per year, if hardboard and insulation board are made in the same plant.

Since residential housing would be the largest consumer of building board, it is necessary to compare the proposed output of a building-board plant with the demand in this field. To such demand would, of course, be added nonresidential building and certain industrial uses of hardboard. Assuming again that Alaska alone would have a maximum population on the order of 1 million persons by 1980, the present population must grow by some 800,000 in 20 years (these <u>are not</u> predictions). A mean growth of 40,000 persons a year must then be housed in the equivalent of perhaps 10,000 residences each year. Using factors somewhat greater than current building practice, a fully developed Alaskan market would use 1000 tons of hardboard and 2000 tons of insulation board a year, far short of that necessary to sustain a plant.

In summation, the local demand for local products, either of logs and lumber, or from pulping and subsequent manufacture, should not rise to the point where a major manufacturing facility could be sustained, in addition to the present sawmill complex. This does not preclude the possibility of increasing sawmill capacity somewhat, rebuilding the plywood mill, or building one or two paperboard-converting plants.

North American Demand and Supply

The continental U. S. and the balance of Canada are the most logical potential consumers of timber and timber products from Northwest North America. Demand in the U. S., especially, has outrun supply for some products and is expected to do so in others over the next two decades. A measure of the opportunity for timber products from Northwest North America can be derived from a consideration of the present and projected consumption-supply balance of the rest of the continent.

<u>Wood and Wood Products</u>. In considering the rest of North America as a market for regional timber products, it is necessary to eliminate roundwood from the discussion. While technically and economically it is feasible to export roundwood from Alaska or the Canadian provinces, legal barriers have been instituted to minimize or prevent this on the basis that this would restrict any chance the region might have to progress industrially by converting its own timber. [32] Similarly fuelwood is an unlikely candidate for the North American markets. What is left, then, includes lumber; posts, poles, and pilings; veneer, and particle board.

United States. Lumber still consumes over half the wood used in the U. S. The major end uses of lumber are in construction, manufactured products such as furniture, and shipping containers, pallets, and dunnage. U. S. total consumption has not changed significantly over the past six decades. While total consumption remained remarkably stable, per capita consumption slumped to less than half that obtaining at the beginning of the century. Faced with a rising relative price level, lumber gave way time and again to competitive materials including building board, paperboard, metals, and plastics.

Domestic production is a function of available resources, market price, utilization of the product mix, and other factors. U. S. production has over all not been able to meet domestic demand, and imports, once a minor factor, have increased to make up the balance. Conversely, exports have declined significantly and are now confined for the most part to certain desirable species.

As shown in Figure V-18, U. S. consumption has ranged from 30 to 40 billion board feet annually, peaking at around 43 billion board feet early in the century, plunging to less than 25 billion during the depression. Per capita consumption decreased from over 500 board feet to less than 150 board feet during the same period. Recovery has carried per capita consumption to the present level averaging about 220 board feet.

Demand for softwood is by far the larger segment of domestic lumber requirements accounting for about 80 per cent of the U. S. total production. In 1959, estimated softwood production was 29.7 billion board feet, estimated hardwood production was 7.2 billion, for a total of 36.9 billion.[33a] Softwoods dominate in construction while hardwoods are usually preferred for flooring, railroad ties, furniture, and other manufactured products. In many uses, of course, either may be suitable.

A consumption of about 55 billion board feet annually is estimated by Battelle for 1980 on the basis of extrapolations of projections made for 1975 and 2000.[1e] This is more than one-third higher than average consumption during the period 1950-1959. Of this 55 billion board feet, about 11 billion would be hardwood, and about 44 billion would be softwood. Domestic timber will, of course, supply the bulk of domestic requirements. However, estimates of projected timber cut show that it is unlikely that all demand can be met economically from "continental" U. S. forest resources alone; most of the imported wood will be softwoods.

Posts, poles, and pilings, together, form the bulk of the miscellaneous category of industrial wood uses. Wood fence posts are primarily used in farm fences. This consumption has declined sharply in recent years, from 900 million posts in 1920 to about 300 million in 1952. Consumption by 1980 should rise to no more than 400 million posts, of which two-thirds are expected to be softwood, one-third hardwood. Domestic supply is expected to be adequate to meet this demand.

Pole consumption, on the other hand, has increased because of new power installations. From about 3.6 million poles annually in the period 1923-1929, consumption rose to 6.5 million in 1952[1f], which also appears to be a reasonable projection for consumption in 1980. These poles, almost all of softwood, can readily be supplied from domestic resources.

Piling consumption has fluctuated widely; in 1952 it amounted to 11 million linear feet, of which 60 per cent was treated. This demand is expected to increase as nonresidential construction increases, exceeding almost 60 million linear feet by 1980. Here, also, anticipated domestic supply is equal to demand.

None of the other minor uses are expected to provide an opportunity for increased import.

Plywood and veneer production has grown sharply. Of great interest is the softwood component of this consumption. From a minor part of the whole, 305 million square feet (3/8-inch basis) in 1930, softwood plywood grew phenomenally, especially after World War II. By 1955 production exceeded 5 billion square feet, and reached an estimated 7.85 billion square feet in 1959.(34) Almost all of this is Douglas fir. Further, almost all softwood veneer is used in plywood – in 1958, for example, all but 1.5 per cent. This plywood is used primarily for construction, but almost one-quarter is used in manufacturing and shipping.

Hardwood plywood and veneer are used primarily for manufactures, although about 25 per cent is used in containers and another 20 per cent as facing and paneling. Some 60 per cent of hardwood veneer is used as plywood. Market shipments of 976 million square feet of hardwood plywood in 1959 indicate a total production of 1,750 million square feet for that year, including an estimated 300 million square feet for containers.

Per capita consumption of plywood in the U. S. has shown a sharp increase over the period mentioned, due in large part to a favorable price relationship with lumber. Plywood manufacture has become efficient and cost conscious; more progress has been made in fuller utilization of veneer logs than in recovery of most marketable grades of lumber from sawlogs.

Demand for plywood is expected to continue its rapid climb. In a recent publication by a major firm supplying the industry, production of Douglas fir plywood in 1975 was projected at 16.4 billion square feet, 3/8-inch basis.(35) Even if this is somewhat optimistic for 1975, it appears conservative for 1980. During this same period, Battelle estimates that demand for hardwood plywood and veneer will increase by 75 per cent, or to about 3 billion square feet by 1980.

As with lumber, the U. S. is now a net importer of plywood and veneer. Exports are negligible compared with imports. Up to the early 1950's, imports were mostly hardwoods of species not available in the U. S. or available in insufficient quantities, such as birch, a major import plywood item from Canada. But in recent years imports of softwood plywood and veneer, primarily from Japan, have increased radically. Table V-26 presents information on exports and imports of plywood for recent years. Net imports are expected to increase as demand for hardwood veneer and plywood increases. The increasing pressure of Japanese production should continue to make imports from that country a major factor in supplying the growing U. S. demand.

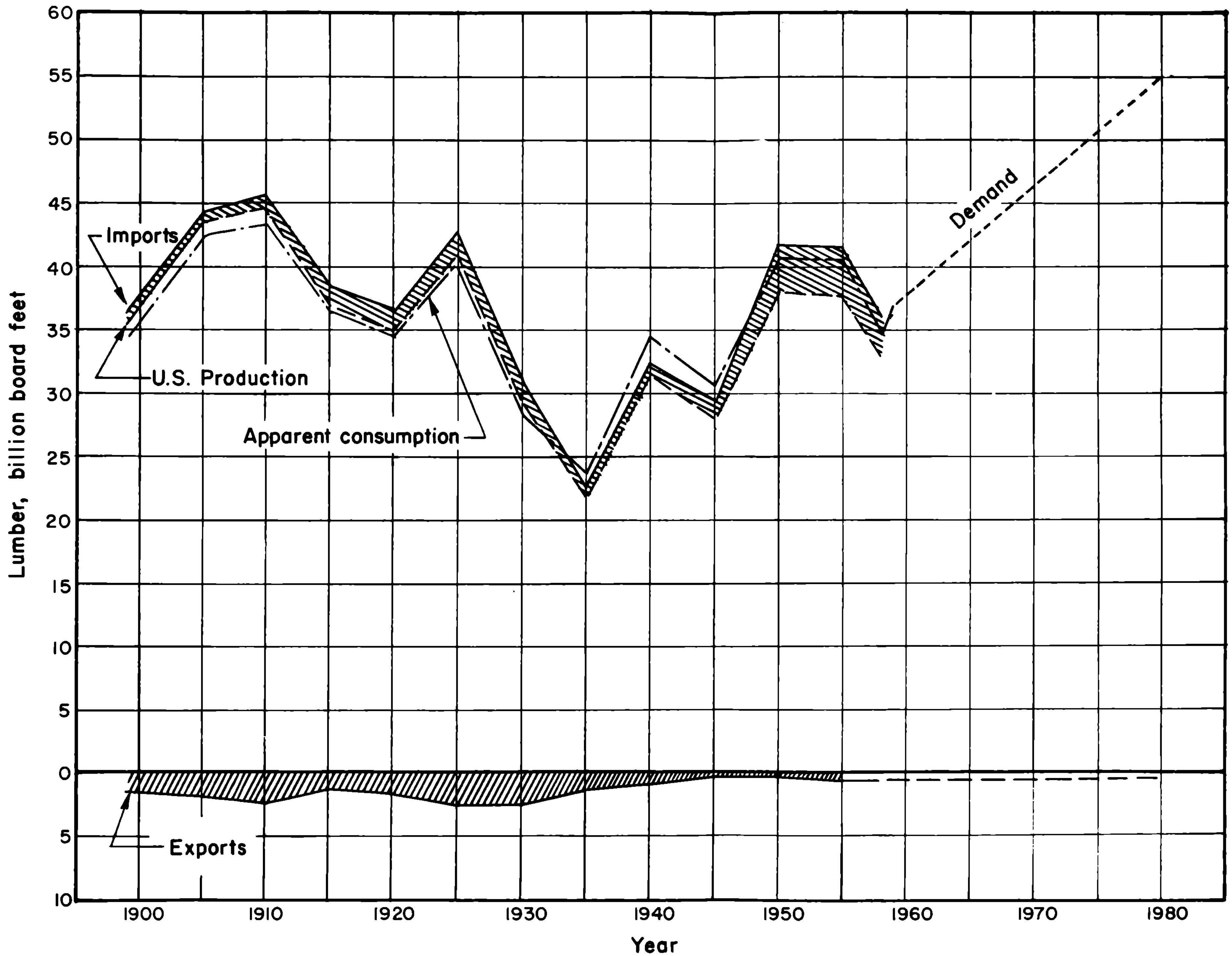

FIGURE V-18. DEMAND FOR LUMBER IN THE U. S., 1900-1959, PROJECTED 1980

Source: "Demand and Price Situation for Forest Products", U. S. Department of Agriculture, Forest Service (November, 1958), p 24.

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TABLE V-26. U. S. EXPORTS AND IMPORTS OF PLYWOOD AND VENEER, SELECTED YEARS[a]

	Plywood, million square feet						Veneer, million square feet			
	Exports[b]			Imports			Exports	Imports[b]		
Year	Total	Soft-wood	Hard-wood	Total	Birch	Other	Total	Total	Birch or Maple	Other
1935	40.8	n.a.	n.a.	0.03	0	0.03	50.4	4.7	n.a.	n.a.
1940	45.2	0	45.2	2.6	0.6	2.0	125.6	16.0	4.3	11.7
1945	127.1	69.7	57.4	0.8	0.6	0.2	95.9	4.4	3.8	0.6
1950	3.8	3.3	0.5	63.2	51.2	12.0	34.5	361.9	161.9	200.0
1955	10.3	8.1	2.2	627.8	156.6	471.2	51.7	765.4	329.0	436.4
1959	14.0	11.8	2.2	1,327.8	136.8	1,191.0	60.7	1,064.0	496.5	567.5

(a) Source: U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, and Bureau of Census 1953-1959.
(b) n. a. = not available.

Particle board is the last separate item of timber products considered. This material has been rising rapidly in importance; as of now the important uses are in furniture and door cores, where veneer, plastic, or other material forms the surface lamination. U. S. production in 1957 was in excess of 182 million square feet of 3/4-inch material;[36] much of the production capacity is captively owned by furniture manufacturers and other users. If particle board finds a major market as a construction material, consumption could soar to over 900 million square feet or more a year by 1980. However, U. S. capacity is in excess of demand now and will be for the foreseeable future. Because of the domestic wastewood-utilization aspect, ease of manufacture, and relatively high freight costs, it is considered unlikely that major amounts of particle board will be imported to meet domestic needs.

Canada. Canada as a whole has been fortunate in the magnitude, availability, and species distribution of its forest resources. Almost from the beginning period of colonial settlement Canadian lumber has been a major item of export commerce. Canadian wood requirements thus are a composite of internal demand and export. Only a minimal amount of wood has been imported, in species and forms not available locally.

Domestic consumption, except for the period of depression during the 1930's, has increased with the population and economic development of the provinces, amounting currently to about 3.5 billion board feet,[16] somewhat under the peak of 4 billion board feet of 1953. Internal demand is projected to rise to about 5.8 billion board feet by 1980, on the basis of trends in Canadian growth. Exports, primarily to the U. K. and the U. S., have roughly equaled internal consumption. Projections of export demand, based on available data, show a 1980 requirement of about 6 billion board feet.[37] Almost all of these requirements will be softwoods. Production to meet domestic and export requirements amounted, in 1958 and 1959, to 7.4 billion board feet. This must rise to 11.8 billion board feet to meet the projected requirements of 1980.

There is no doubt but that Canadian production can exceed internal needs. For production to meet export needs as well also seems to be within the capabilities of the large forest resources at hand. Considering the timber cut as roundwood, without regard to its utilization, by 1980 all projected requirements would amount to roughly three-fourths of the allowable annual cut of accessible timber, somewhat over half of the total available annual cut if less accessible regions are brought into play.

To meet these needs, more and more remote areas will have to be brought into production. Logically indicated areas are northern British Columbia and western Alberta, rather than the more distant and less timber-rich Yukon and the western Mackenzie district. The supply picture is complicated by the increasing cost of wood obtained from remote regions, especially since the timber in these regions is neither as dense nor does it grow so large as in, say, the coastal region of British Columbia. Another complicating factor is the tariff pattern which affects export to the U. S. and which may change under changing economic and political situations.

Minor products such as posts, poles, pilings, mine timbers, and others are comparatively insignificant in the Canadian economy. Estimates for total domestic and export requirements of the miscellany of included products amount to about 490 million board feet. Existing and local supply should meet these requirements without the need for new resources.

The plywood industry has rapidly expanded to meet Canadian needs. Softwood plywood originates from coastal British Columbua, based on Douglas fir. Production rose from 1940's 147 million square feet to 1,119 million square feet in 1959.[33b] Projected production for 1980 amounts to 2.1 billion square feet. This should all be consumed in Canada except for the 4 per cent or so which will probably be exported. The U. S. tariff and competition from other materials in England, the major market, limit export possibilities. Suitable veneer logs from the Canadian segment of Northwest North America should form the basis for plywood production to meet projected requirements. Also, there will probably have to be greater acceptance of non-Douglas fir plywood, but this seems inevitable.

Hardwood plywood is also produced in Canada but not to the extent of softwood plywood. Export, almost entirely to the U. S., plays a larger proportionate part here. Canadian consumption is estimated to rise from 1954's 164 million square feet to 250 million square feet in 1980. However, export should remain stable at about 60 million square feet. An adequate supply of suitable veneer logs is questionable. Yellow birch is diminishing in availability and may restrict this market. The U. S. market at least may be supplied from either domestic production from that country's large hardwood resources, from development of the birch stands of interior Alaska, or, of course, from foreign sources.

Canadian veneer, both softwood and hardwood (yellow birch), is mostly exported to the U. S. Total veneer production in 1957 amounted to 1,025 million square feet (1/10-inch basis)[38] of which about 80 per cent went to the U. S. No projections have been made for this material. It is assumed that consumption will increase by 1980, but export may diminish. Softwood veneer is exported to one U. S. firm, while hardwood veneer is limited by available birch supplies, and by competition from abroad (Japan). Of course, even if Canadian birch no longer supplies this market, but Alaskan birch does, then the region as a whole will have retained or increased its output.

Particle board is not yet an important item in Canadian wood industries. Present domestic consumption is quite small as is the export market. Because of the major dependence of this industry on sawmill waste or logging residue, it seems unlikely that

Canadian demand outside the region of Northwest North America will be satisfied by other than local production.

Pulp Products. North America is at once the largest producer and the largest consumer of pulp products. The over-all historical pattern of growth is projected to continue, predicated on an increasing level of population and economic activity. Of course, not all grades and classes of pulp, paper, and board will share equally in this growth. But most segments of the industry exhibit a growth rate that will require the development of new resources at a rapid rate to meet the domestic and export needs of the U. S. and Canada.

United States. The U. S. is the largest world consumer in almost every category of pulp, paper, and board. Except for newsprint, domestic production suffices to meet the major portion of domestic needs although a substantial import and export trade also exists.

Market pulp in the paper and board grades is purchased by specialized paper mills as their sole or partial supply or by vertically integrated paper mills to supplement or temporarily relieve pressure upon their own internal sources. In the U. S. the larger part of market pulp originates from vertically integrated firms that sell the excess of their requirements. By and large, market-pulp consumption in this country has remained stable in quantity but has declined sharply as a percentage of pulp consumed. There is no reason to expect a reversal of the trend toward vertical integration and the consequent decrease in open-market purchases of pulp. However, import of foreign pulp and perhaps the abandonment of less efficient owned pulp facilities, together with sales pressure from presently established and the few new market-pulp mills, should enable paper-grade market pulp to continue to supply perhaps 10 per cent of U. S. requirements. On this basis, paper-grade market pulp requirements could rise to 5 million tons by 1980, since an extrapolation of U. S. total wood-pulp requirements for that year indicates a consumption of about 52 million tons.[1g]

Dissolving-pulp requirements are influenced by the demand for the end products made from this pulp by the chemical industries. These are primarily rayon and cellophane, plus a variety of plastic, photographic, and other uses. Dissolving-pulp use in the U. S. rose rapidly from 1940 to the mid-1950's but has since leveled off, never regaining the peak of 1955. This has apparently been due to increasing pressure from competitive film and filament materials, viz., nylon, polyethylene, and other synthetics. Projections of future U. S. consumption vary widely, but a reasonable level in the face of present and expected competition could be 2 million tons by 1980.

U. S. capacity well exceeds its present requirements for market pulp, both paper and dissolving grades. In sulfate and sulfite pulps, which constitute almost all market pulps, domestic capacity for paper-grade material exceeds 18.5 million tons[39], and of this, well over 3 million tons can be considered market capacity.* To this must be added Canadian capacity which exceeds 2 million tons per year for market pulp since pulp bears no tariff when shipped to the U. S. Domestic dissolving-pulp capacity now exceeds 1.4 million tons and is expected to rise to 1.7 million tons by 1965. To this must be added Canadian dissolving-pulp capacity of 0.5 million tons, production from which is sent mostly to the U. S.[39]

*Battelle estimates.

Figure V-19 shows the source of market pulp consumed in the U. S. over recent years. In view of the present U. S. and Canadian capacity for market pulps of both types, and in view of the projected level of demand, it does not appear likely that production of market pulp would provide a sound basis for a new mill in either Alaska or Canada to supply North American consumption requirements alone.

But market pulp is but a part, and much the less significant part, of domestic pulp requirements. Wood pulp consumption, from whatever source, has risen from less than 4 million tons in the early 1920's to over 23 million tons in 1958. Consumption in 1960 should exceed 27 million tons(40), and this quantity must almost double to about 52 million tons in order to provide the requisite material for the paper- and board-products consumption projected for 1980.

To meet this projected increase of an additional 25 million tons of wood pulp annually, domestic U. S. producers are expected to increase their imports of pulpwood; increase market pulp purchases somewhat, including quantities from Canada and abroad; and make more effective use of domestic timber. This implies better forest utilization and management, including the use of material that is now wasted in the forest or the sawmill, and the increasing use of hardwood, as well as coniferous species now utilized only partially or not at all. Near-future projected demand is pressing upon present capacity. U. S. capacity for paper grades of pulp is about 27.5 million tons a year(39a), a figure which should be exceeded during 1960 or shortly thereafter. It seems logical to expect that part of Northwest North America, specifically Southeastern Alaska, would be developed to supply pulp by an integrated firm in the paper and board industry. This does not apply to interior Alaska where the economics of a pulp operation are dubious under foreseeable economic conditions and demand. Pulp production in Canada should come under the "market pulp" factors considered above which should not alone justify exploitation. However, pulping facilities to enlarge Canadian supply for internal and export needs will be discussed in a following section.

Newsprint is one of the most important paper products consumed in the U. S., second only to container board (used to make corrugated boxes). Because of its importance as a material and the impact on its consumption by business activity (through advertising lineage) and population growth, it is also one of the most frequently studied materials. The U. S. has been, is, and is likely to remain a deficit nation in newsprint production. By far the larger part of domestic requirements must be imported, almost all from Canada, as shown in Figure V-20. To satisfy 1958 consumption of about 6.5 million tons, U. S. production of 1.8 million tons was supplemented by over 4.5 million tons of Canadian newsprint.(41) A minor additional quantity is imported from northern Europe while a similarly small amount is exported.

The proportionate share of U. S. production is rising. From a low of about 17 per cent in 1950, U. S. producers now supply over 26 per cent of U. S. requirements. Whether they hold this ratio, as many anticipate, in the face of projected increases in demand, depends on the further development of the domestic newsprint industry in the southern pine regions.

Domestic consumption is estimated to reach 10.5 million tons by 1980. This reflects a somewhat lower rate of growth in the future than in the past because of increased competition for the consumer's attention from television, magazines, and other media, and because of the decreasing number of newspapers in the country. In terms of opportunity for Northwest North America, although this will be discussed in more detail later,

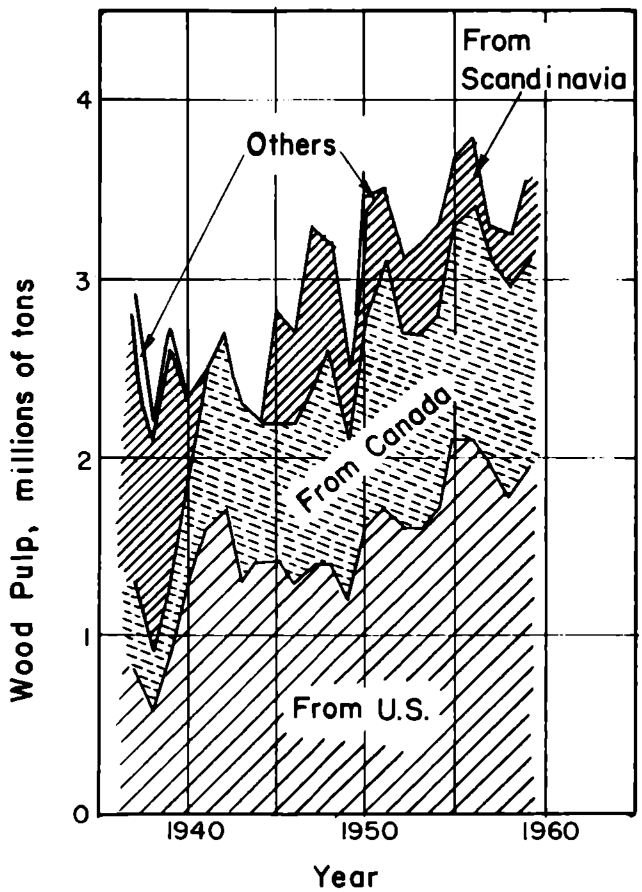

FIGURE V-19. NEW SUPPLY OF MARKET PULP, BY COUNTRY OF ORIGIN, 1935-1959

Source: "Wood Pulp Statistics", U. S. Pulp Producers Association, Inc. (August, 1958), p 49; U. S. Department of Commerce Census, U. S. Imports of Merchandise for Consumption.

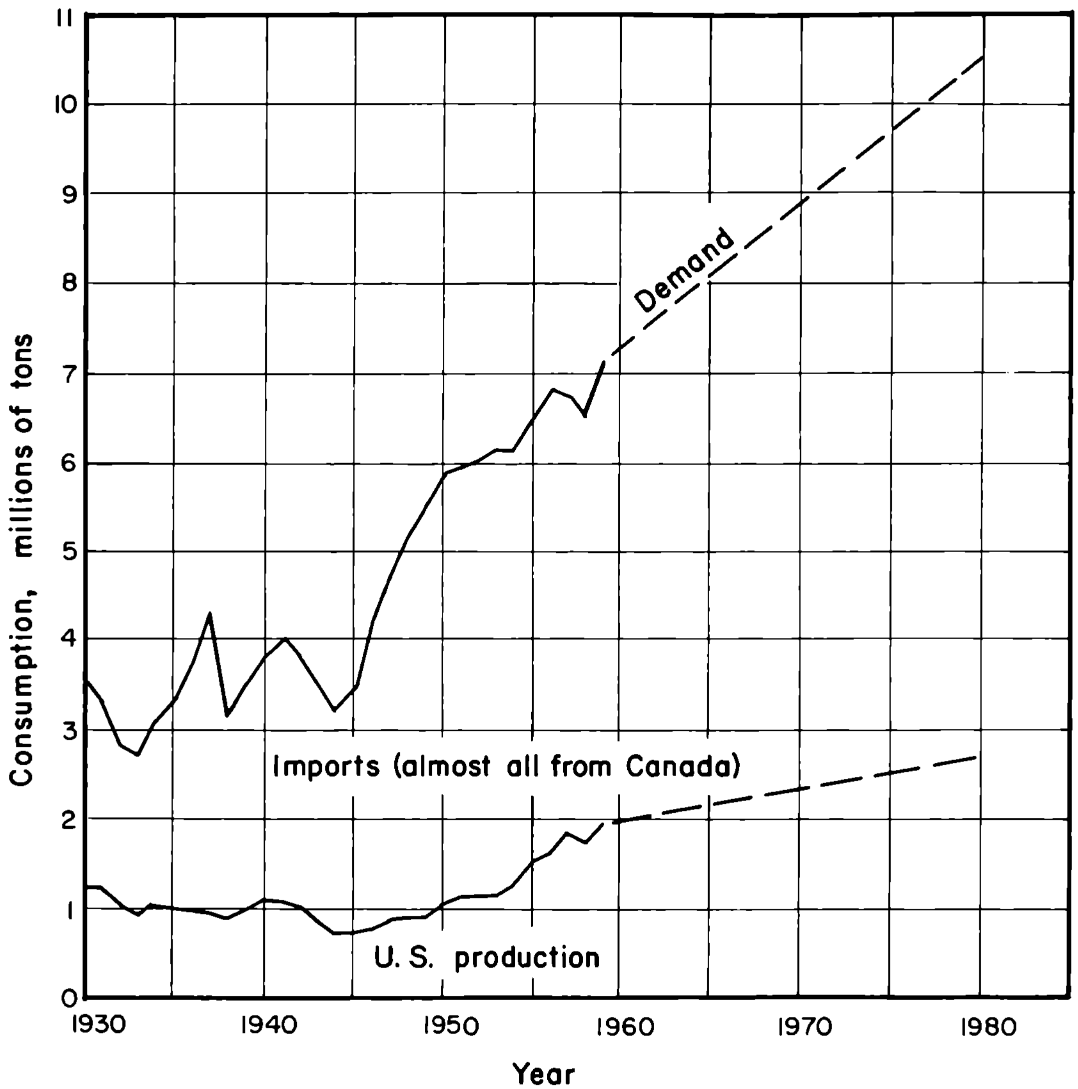

FIGURE V-20. CONSUMPTION OF NEWSPRINT IN THE UNITED STATES, 1930-1959, PROJECTED 1980

Source: "Pulp, Paper and Board Supply-Demand", and supplemental reports, U. S. Department of Commerce, Business and Defense Services Administration.

it appears that newsprint is an area where a ready-made demand not satisfied by domestic production exists.

Other paper and board, besides newsprint and building material, comprise several broad categories. Paper may be classified as groundwood; book, fine and absorbent; tissue and sanitary. Board can be divided into container board, bending board, nonbending board, and a miscellaneous category. Each of these may, of course, be subdivided into hundreds of minor classes.

Consumption of paper (other than newsprint) and board increased from 9 million tons in 1935 to about 32 million tons in 1959. Exports and imports of paper exclusive of newsprint are minor and almost in balance. Exports of board are somewhat more significant, amounting to about 3 per cent of production, while imports are minimal. U. S. consumption of paper and board in this category is shown in Figure V-21.

Projections made by Battelle indicate a consumption by 1980 of 26.7 million tons of paper, exclusive of newsprint. Paperboard has increased rapidly as its versatility expressed itself in new forms and functions; growth since 1929 has been at the rate of 5 per cent per year. Consumption by 1980 has been projected as 27.6 million tons. Total consumption in 1980 of paper and board as defined could then amount to 54.3 million tons.

Domestic supply to this market will be conditioned by the availability of wood pulp and wastepaper, so the comments made above relating to wood pulp apply here. It is possible that coastal Alaska could be the site of a paper or paperboard mill to supply continental U. S. requirements if the relatively low cost of stumpage would offset the relatively high labor cost which is more important in the formation of paper or board than in pulp making. This is not true for the Canadian segment of Northwest North America unless present tariff restrictions on paper or board are modified or unless alternative U. S. sources of supply rise in relative cost.

Canada. Canada is the world's major exporter of pulp and paper products, although most of the nonpulp export trade is concentrated in newsprint; the industry is completely export oriented since only a small percentage of capacity could be utilized within Canadian borders. Therefore, in discussing Canadian needs, cognizance must be taken of both internal consumption and export.

Canada exports paper and, to a lesser extent, nonpaper (dissolving) market pulps. Most of the pulp is shipped to the U. S., while much of the remainder is shipped to the U. K. and the European continent. Canadian production of pulp reached 10.4 million tons in 1957, somewhat down from the peak in 1956 of 10.7 million.[39b] Of the 1957 production, 2.3 million tons were exported while the rest was consumed internally to make newsprint and other paper and board products. Market paper pulp sold to Canadian consumers amounts to about 1/4 million tons and so is relatively insignificant. To avoid double counting, it has been included in projections made for market pulp as a whole.

To meet the projected increases in need for wood pulp for the U. S., U. K., the European continent, and other traditional customers, an increase in wood pulp from Canada will be required. This has been estimated on the basis of the present and projected supply pattern of these regions and includes only logically anticipated

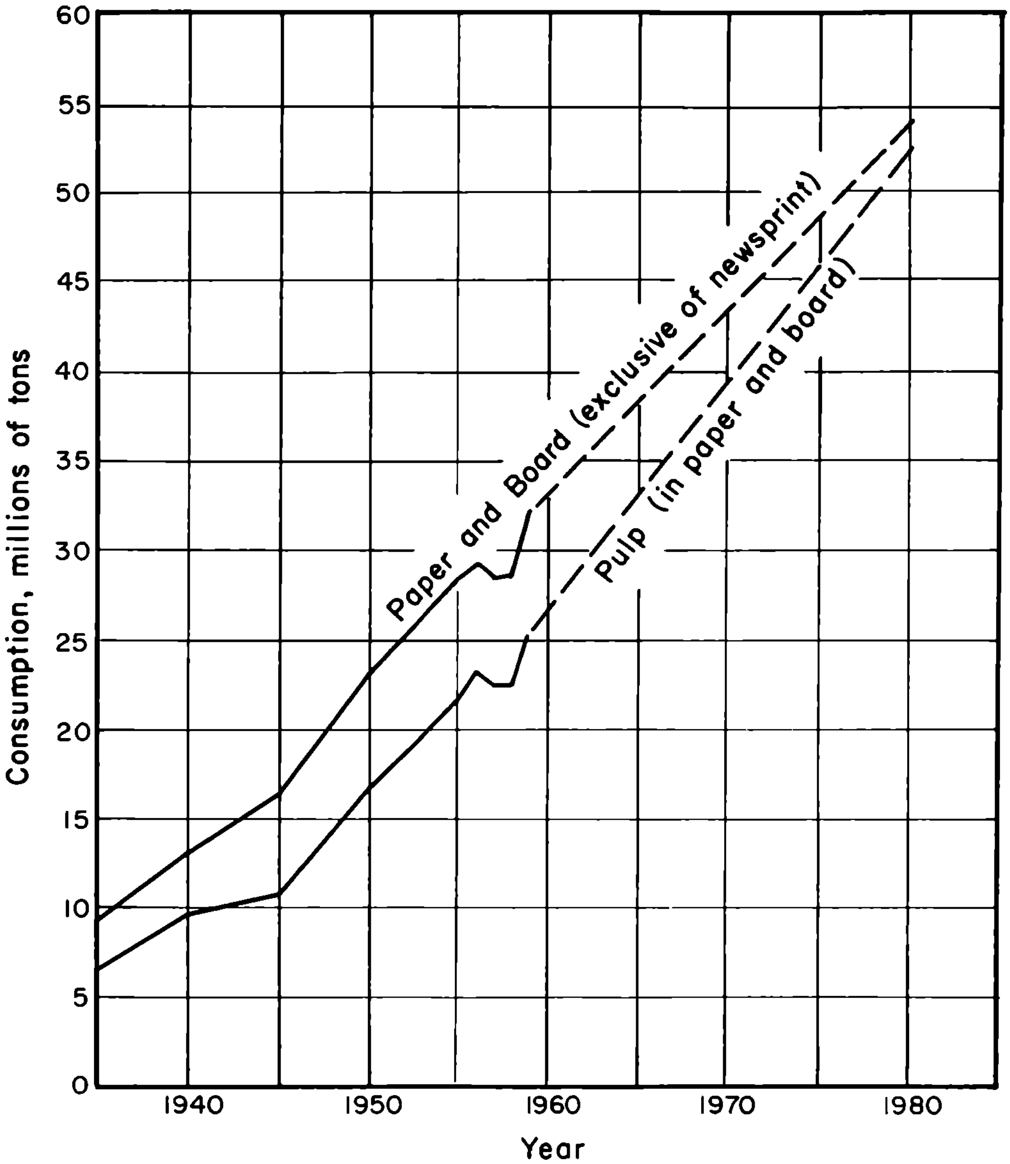

FIGURE V-21. U. S. CONSUMPTION OF PULP, AND PAPER AND BOARD, 1935-1959, PROJECTED TO 1980

Source: U. S. Pulp Producers Association, Inc.; U. S. Department of Commerce, Business and Defense Services Administration.

opportunities which would not be satisfied by other sources. On these bases, the demand for Canadian market pulp should rise to just over 5 million tons by 1980, as shown in Figure V-22.

Canadian dissolving-pulp consumption has been quite small, hovering around 50,000 tons in recent years. Such consumption is projected to increase as the requirements of Canada's growing population for such things as rayon, cellophane, and other materials increase and are satisfied by domestic production. By 1980, Canadian consumption of dissolving pulp might reach 165,000 tons. Canadian production has dropped sharply from the 1954 peak of almost 400,000 tons to the 1957 level of somewhat over 260,000 tons. This has been due to some loss of markets for the end products, but primarily because of alternative sources of supply in a field where considerable overcapacity exists. This is especially true in view of the new mills in Alaska, the U. S., and Europe. At any rate, the projection made for market pulp above includes the future export of dissolving pulp.

Canadian newsprint consumption of about 400,000 tons has, of course, been a minor factor in the creation of an industry producing over 6 million tons a year, as shown in Figure V-23. Since newsprint and pulp travel tariff free in many of the world's markets, these represent the huge growth of the Canadian forest industries in fiber products.

As already noted, the U. S. is the largest consumer of newsprint and receives most of its needs from Canada. Despite the growth of the southern pine-based newsprint industry, the large majority of U. S. newsprint should still originate from Canada in 1980. A projection has been made that of the 10.5 million tons that the U. S. will consume in 1980, about 2.7 million would come from its growing domestic supply and 7.6 million from Canada, half again as much as is now shipped.

To this projected U. S. demand for 7.6 million tons must be added the growing Canadian consumption, expected to more than double, to perhaps 1 million tons by 1980. Moreover, Canada is also an important supplier to the rest of the world. World demand for newsprint is discussed in more detail in the next section, but is expected to rise to well over 30 million tons by 1980. Of this, Canadian production can logically be estimated to supply 3.8 million tons, based on present and projected facilities, species of fiber, and other factors. These three markets add up to a total demand upon Canada for 12.4 million tons of newsprint in 1980, or about double that of today. By analogy, this will require almost a two-thirds increase over present newsprint capacity of 7.5 million tons.* If the arbitrary but realistic assumption is made that this increase in demand will be satisfied by an equivalent number of plants, each producing 250,000 tons per year, then 20 new such pulp and paper mills would be required in the next 20 years.

Because of the tariff factor, Canadian production of other grades of paper and board, except building, has been primarily for home use. Canadian exports of all such products rarely exceed 200,000 tons a year. Therefore, projections of consumption depend on a growing population and a growing per capita use. Canadian consumption of all grades of paper and board except building amounted to about 1.3 million tons in 1955. This is expected to rise to perhaps 3.5 million tons by 1980. It can be seen that domestic demand alone would require more than a doubling of capacity, since present facilities are now operating at or close to capacity. Considering the sizes of various recent installations, perhaps 8 to 12 new mills would be required to supply this demand.

*This discussion is based on data from References (1), (9), and (41).

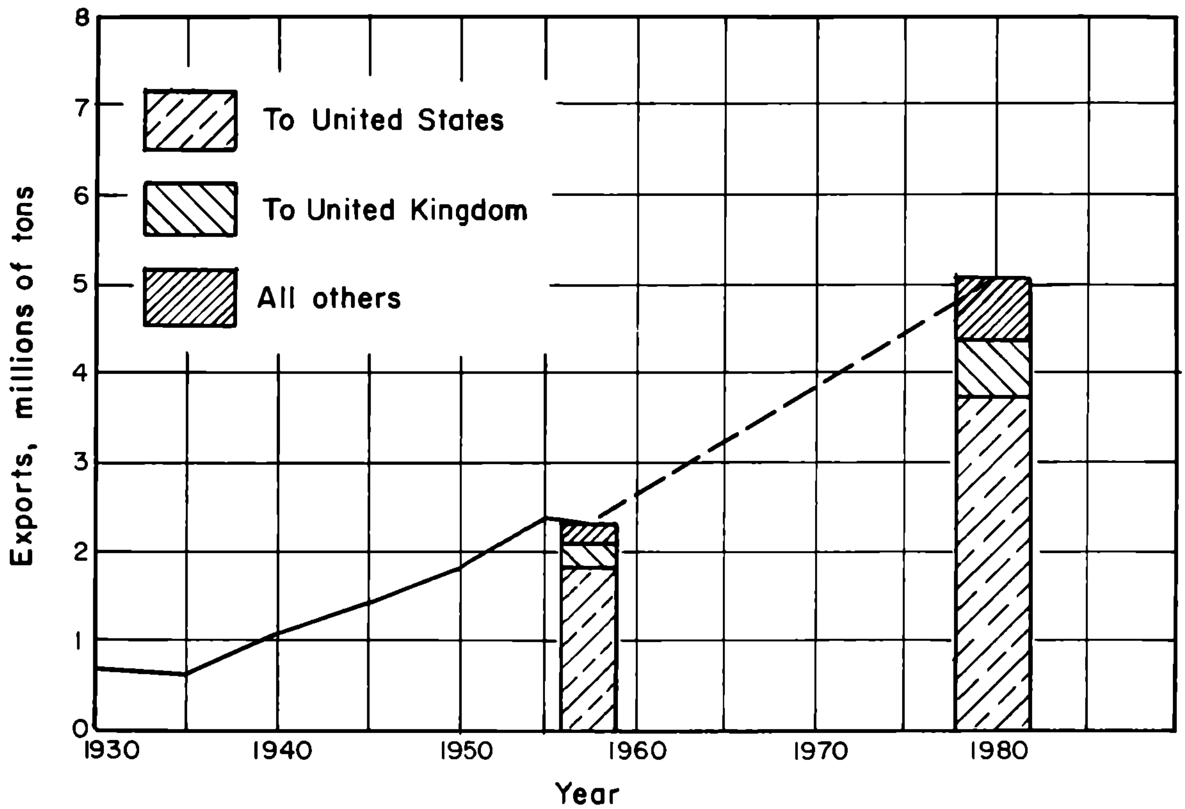

FIGURE V-22. EXPORTS OF CANADIAN PULP, 1930-1957, PROJECTED 1980; DISTRIBUTION OF EXPORTS TO CONSUMER COUNTRIES, 1957, PROJECTED 1980

Source: Dominion Bureau of Statistics; Canadian Pulp and Paper Association.

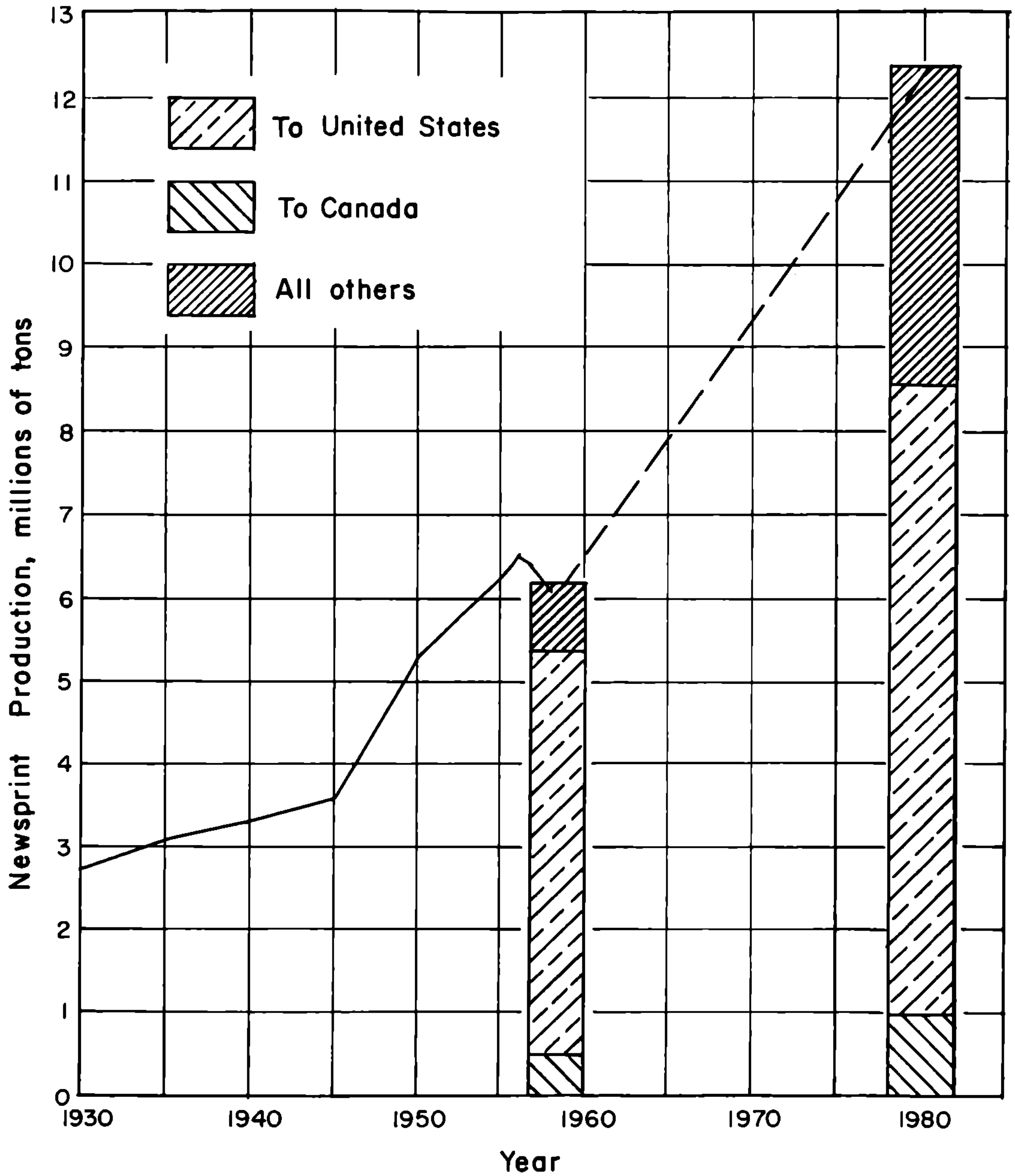

FIGURE V-23. CANADIAN NEWSPRINT PRODUCTION, 1930-1958, PROJECTED 1980; DISTRIBUTION TO CONSUMER COUNTRIES, 1958, PROJECTED 1980

Source: U. S. Department of Commerce, Business and Defense Services Administration.

Canada produces both hardboard and insulation board. While a significant quantity of hardboard was exported to the U. S. in years past, this has decreased considerably, so that exports are not presently an important factor. Nor, as U. S. capacity increases and the pressure of new and planned Scandinavian facilities grows, is export likely to provide opportunities for Canadian board. Rather, demand should depend on internal consumption. On this basis, the industry, which produced 230,000 tons in 1958(42), is expected to reach 575,000 tons in 1980. However, only two or three plants of the size thought to be most economic would be required to produce this estimated quantity. Roundwood is but one possible input, since screenings, tops and limbs, undesirable species, and otherwise waste forest products can be used to make acceptable building board. Most economically, the building-board plant is part of a forest complex of pulp mill, sawmill, and perhaps veneer mill, to obtain optimum usage of the forest output.

In summary, to meet the expected increase in demand from market-pulp, newsprint and domestic requirements, Canadian pulp production must rise to almost 21 million tons by 1980.

Export-Market Potential for Northwest North America

The world harvest of timber in 1956 was upwards of 308 billion board feet, reflecting a steady rising trend during the post-World War II period. The development that is occurring in all regions in industrialization, housing, and an increasing standard of living has placed growing demands on natural forest resources. To meet local demands, and in growing recognition of the vital part that forests play in economic development, a major world trade exists to strike a balance between the surplus of one area and the needs of another. In 1956, about 10 per cent, or 30 billion board feet, entered into the export trade.

The major surplus supply areas are North America and the U.S.S.R. The eastern U.S.S.R., especially along the Amur River, harbors an enormous reserve of timber for potential future supply to the world. Within Europe, Scandinavia is a substantial surplus area. The rest of the world is currently more or less deficit in sawn wood, pulp wood, and other forest products so that these regions are net importers, although they may of course export certain specialized products. Table V-27 presents information on the net balance of trade in forest products.

The remainder of trade in forest products was intraregional.

Since both the Alaskan and Canadian portions of Northwest North America are and would be exporters to the rest of the world, there is no reason to treat them separately. Each must attempt to market its exportable surplus on essentially equivalent terms, setting aside such factors as tariff or membership in an organization of nations.

TABLE V-27. NET BALANCE OF TRADE IN FOREST PRODUCTS[a]

Region	Million Board Feet 1955	1956
Europe	-720	-175
USSR	+890	-
North America	+2,450	1,450
Central America	-230	-230
South America	-580	-370
Africa	-250	-150
Asia	-480	-500
Pacific Area	-600	-460

(a) Source: "Yearbook of Forest Statistics", UN, FAO, Rome, Italy (1957).

World Wood Demand and Supply. Almost all of the market areas considered most likely for Northwest North America are net importers of coniferous sawn wood. Asia, Central America, and South America are net exporters of broadleaved sawn wood, leaving the remainder of the world as importers. Table V-28 shows the extent of this trade in 1955.

TABLE V-28. REGIONAL TRADE BALANCE IN SAWN WOOD, 1955[a]

Region	Sawn Wood, million board feet Coniferous	Broadleaved
North America	+860	-460
Central America	+18	+4
South America	Not available	+8
Asia	-173	+160
Pacific Area	-145	+19
Europe	-460	-116
Africa	-271	-27

(a) Source: "Yearbook of Forest Statistics", UN, FAO, Rome, Italy (1957).

Plywood is another major factor in world trade. In 1956, about 2.2 billion board feet of plywood were produced and of this some 186 million board feet were exported, or about 8.5 per cent.(43) Japan and Finland together supplied over half this amount.

Further consideration will be limited to sawn and processed woods, such as plywood, although much of the world's trade is in roundwood and pulpwood. The restrictions on shipping unprocessed logs out of Alaska, with minor exceptions, preclude the growth of a roundwood trade. Furthermore, the trend is against an increase in the pulpwood trade from Canada. Trade in broadleaved woods will not be discussed since these form so small a proportion of available timber from Northwest North America.

Europe is the world's major coniferous importing region, taking in 1956 about 54 per cent of all imports; at the same time Europe provided about 46 per cent of all exports.(43) England, Germany, Italy, Belgium, and Holland are the major importing nations, but most of their needs are satisfied from the timber of Northern Europe and Russia. Only the U. K. has taken major amounts from Canada and the U. S. in the past.

Mexico and Cuba have been major importers, primarily from the U. S. In South America, Peru has been the largest importer from the U. S., while Brazil has supplied the needs of Argentina and Uruguay.

In Africa, the Commonwealth countries (Union of South Africa, Federation of Rhodesia, and Nyasaland) have been supplied mostly from Canada and the U. S. France and Sweden have also been important suppliers to this area.

Japan is the major customer in Asia, importing about twice as much from the U. S. as from Canada. Australia in the Pacific area is supplied by Canada and almost as much by the U. S.

Timber from Northwest North America would probably fit into the above patterns in varying ways. However, additional Canadian timber would have an easier entry into its already established markets. Alaskan quantities and species are not fully established in world markets and would have either to displace present suppliers or share in the expected growth of these markets.

The quantity exported by the U. S. to those countries most likely to consume Alaskan timber amounted to about 425 million board feet in 1955.(43) As the needs of these countries increase, so their demand for U. S. timber should increase despite the possibility of satisfying some of this demand from other areas. This demand might rise to as much as 600 million board feet by 1980; the additional requirement for 175 million board feet provides some limited opportunity for Alaskan timber. An encouraging aspect is the current Japanese requirement for Alaskan timber.

Plywood is another possibility in the world market, although a more remote one since Alaskan timber is not of the most widely accepted species. Supply of veneer logs also limits volume market possibilities. Canada is a supplier on a relatively small scale, in a world market increasingly dominated by Japan and Finland. Alaskan and increased Canadian plywood would have to offset the lower cost pattern of the two major producers. The world-market import pattern in those regions most likely to be a market for Alaska, at least, amounted to less than 5.5 million board feet, of which 25 per cent was supplied by Japan, 38 per cent by France, and 14 per cent by Finland.(43) Little opportunity seems to remain for new entry from a high-cost area, despite a potential growth in demand, except perhaps for a specialty product. Further, other sources of supply are being brought into play in the underdeveloped timber regions of the world.

On balance, Canadian timber from Northwest North America should find its outlet in traditional and expected export markets but should not otherwise affect the Canadian timber export pattern. Sawn timber from Alaska should have a modest opportunity in selected world markets based on the past and anticipated demand pattern of these countries.

World Pulp Demand and Supply. Many aspects of the pulp, paper, and board markets have been discussed in other contexts. It is necessary to examine these markets briefly on a world scale to determine if they offer an opportunity for development of the forest resources of Northwest North Africa.

Dissolving and Market Pulp. Dissolving-pulp capacity worldwide is well in excess of present demand. As of January 1, 1960, this capacity amounted to about 3.9 million tons, to satisfy a world demand of about 3 million tons.[44] If world consumption rises at the rate projected for U. S. consumption, then demand by 1980 could exceed 5 million tons. This would require an increase in capacity of over 1 million tons, or the equivalent of perhaps six good-sized mills. Alaska and British Columbia are already the seat of over 25 per cent of North American capacity, and could logically be expected to supply the growing needs of the world to a greater extent, after demand begins to press on available supply.

Excluding dissolving pulp, little opportunity appears to exist in market pulp other than what has been the pattern in prior years. Canada is a major exporter of market pulp, and development of its portion of Northwest North America should include mills to satisfy this growing market as discussed in a prior section.

There is no reason why exportation of market pulp from Alaska should differ from that of British Columbia or of the U. S. as a whole, especially the Northwest Pacific region. The U. S. exports only 300,000 to 400,000 tons of paper-grade pulp and has not been able to increase this in the face of increasing European competition. Further, more and more mills in market areas such as Japan, India, Asia, and Africa are being built based on local fiber consumption. In South America, Africa, Asia, and other areas the local fiber, whether it is tropical hardwood, bagasse, bamboo, or other, has not even been scratched as a pulp source. As the pulp needs of these areas increase they are more likely to be met by local production than by import.

Newsprint. Most countries of the world are deficient in newsprint and are likely to remain so for at least the period under study. Spruce, fir, and hemlock remain the ideal materials for mechanical pulp for newsprint although certain pines and poplars have been increasingly used. Certain processes do permit the use of hardwoods to a greater degree, although at this stage there are no proven satisfactory all-hardwood newsprints available.* Materials such as bamboo and bagasse can provide a usable newsprint.

The production of newsprint is of lowest cost in large mills which have the advantage of economic scale over smaller mills. Such an advantage may be offset by a tariff or other barrier. Consumption in most countries of the world is too small to use the output of such a large mill. This is encouraging for present and future exporters of newsprint.

World consumption of newsprint in 1955 amounted to 12.4 million short tons of which 7 million were consumed in North America. By 1975[45] world demand could exceed 28 million tons, requiring almost double the plant capacity of today, estimated at 15.8 million tons, exclusive of the Communist bloc.[46] Latin American demand should rise to 2 million tons, Japanese demand to 1.75 million tons, other Far East

*It appears likely that one will shortly be developed.

(exclusive of mainland China) demand could rise to 950,000 tons, and Oceania demand could rise to 650,000 tons.(47) These areas alone represent an increased demand for 3.5 million tons of newsprint requiring perhaps a dozen new installations of large-size mills. To this must be added the increase in demand in the rest of the world.

Northwest North America seems in a favorable position to build and expand its position as a newsprint supplier, as demand rises throughout the world. This should occur despite the striving to create a local industry based on available fiber that is the preoccupation of many governments in the market areas mentioned above.

Other Paper and Board. Demand for the multitude of products in this broad category is expected to rise from about 22 million tons in 1955 to about 65 million tons by 1975 in all regions exclusive of North America.(47) However, this gap of 45 million tons does not present nearly so great an opportunity for Northwest North America as might otherwise be anticipated. So many grades and varieties of board and paper are included that it is not possible briefly to sort out major categories similar to newsprint. Further, local production based on exploitation of available fiber supply such as tropical hardwoods, bamboo, grasses, etc., is expected to supply most of the demand. Traditionally, there are tariff barriers or other limitations on the flow of such products that should encourage local industry and limit import.

There is no prior history of significant quantities of export from Canada or the U. S. to supply world demand. Canadian projections look for but 1/2 million tons of product to be exported in all grades of paper and board, other than newsprint, by 1980. U. S. exports, currently about 3/4 million tons, might well increase to double that by 1980, or 1.5 million tons. But these figures cover many diverse products so that it is difficult to justify the creation of new facilities on this basis alone. In summation, no mills are likely to be established in Northwest North America to supply the export market alone, although export of various papers and boards might well amount to a significant total.

The Development of Northwest North American Forest Resources

The preceding résumé of the resource base, the past and present utilization of the forest, the potential markets awaiting the type of forest product which could originate from the region, and the alternative sources available to supply these markets all lead to a necessary consideration of the future in the light of these factors. There is, of course, the vital additional factor of accessibility and, therefore, transportation. Some of these resources cannot be adequately developed until methods of ingress and egress are assured. Unfortunately, the expensive construction of transport systems often depends on the prior existence of justifying traffic. To resolve this circularity is a primary objective of the over-all study.

As a general conclusion, development of the forest resources does not depend on radical additions to present transport systems, but rather on extensions or modifications of present ones, e.g., logging roads, possible lower water and rail rates, and in some regions, road and rail networks to connect to the main transport arteries in existence. At the same time, it should be borne in mind that higher prices in other production areas nearer to markets may arise as shortages and high costs develop. These could improve the competitive situation for Northwest North America producers. Such development and its possible impact on transport requirements is discussed in the following sections.

Alaska

The development of Alaska forests, at least in the southeastern region, has already begun with the establishment of two dissolving-pulp mills. The consideration being given and the options held by forest-product firms for most of the remaining timber lend strong encouragement to the eventual full development of this portion of Alaska – certainly before 1980. There is no reason to believe that similar development will occur in the interior, except in very specialized instances.

Most of this development will be in the pulp industry, because of the relative scarcity of Alaskan timber suitable for sawmilling and plywood. The impact of such full-scale development upon Alaska's regional economy should be substantial.

At the time of this writing, most of the timber available for pulp-mill exploitation in the southeastern region, the National Forest, has been allocated and partially developed as shown in Figure V-24. But this allocation was based on earlier surveys of the resources. More recent data indicate a larger resource and thus room for additional development.

On the basis of the earlier estimate of a sustained annual yield of 750 to 800 million board feet, it appeared that about full commitment has been made, as shown in Table V-29, with a small margin for contingencies. Therefore, no additional large contracts will be let until further surveys and experience indicate that there is sufficient timber. But preliminary results of later and more intensive Forest Service studies indicate that about 870 million board feet are available on an annual basis and even this may be too conservative. The allowable cut, calculated now on the basis of 95 per cent in decadent stands, should increase at the rate of 1 per cent per year as these are replaced by second-growth stands yielding somewhat larger volume per acre. Accepting this, it then appears that additional contracts may be let to use perhaps 150 million board feet annually and still maintain some margin. This is sufficient to support one additional pulp mill of significant size. It is likely that this timber sale would be based more on the Chugach, presently not utilized, than on the Tongass, site of the four present and optional holdings. The Yakutat area alone could probably support 50 to 60 million board feet for a medium-size pulp mill, plus a sawmill.

The total pulp and paper output of the coastal region would, under full development, use about 750 million board feet a year to produce somewhat under 1 million tons of product. Naturally, this figure can vary widely depending on the nature of the pulp or paper product to be made. Battelle's calculations are based on the production of about 1000 tons per day of newsprint and 2000 tons per day of bleached pulp, dissolving or paper grade, for a total of 3000 tons daily. On an a priori basis, the consensus is that it would be more efficient to produce pulp than newsprint in Alaska, primarily because of the high labor and power costs. But the tentative plans of Georgia-Pacific Alaska Company to build a newsprint mill with an initial capacity of 500 tons per day, rising to 750 tons per day by about the end of the period under study, plus the tentative plans of Pacific Northern for a mill of smaller scale, indicate that newsprint might be made in Alaska despite these handicaps.

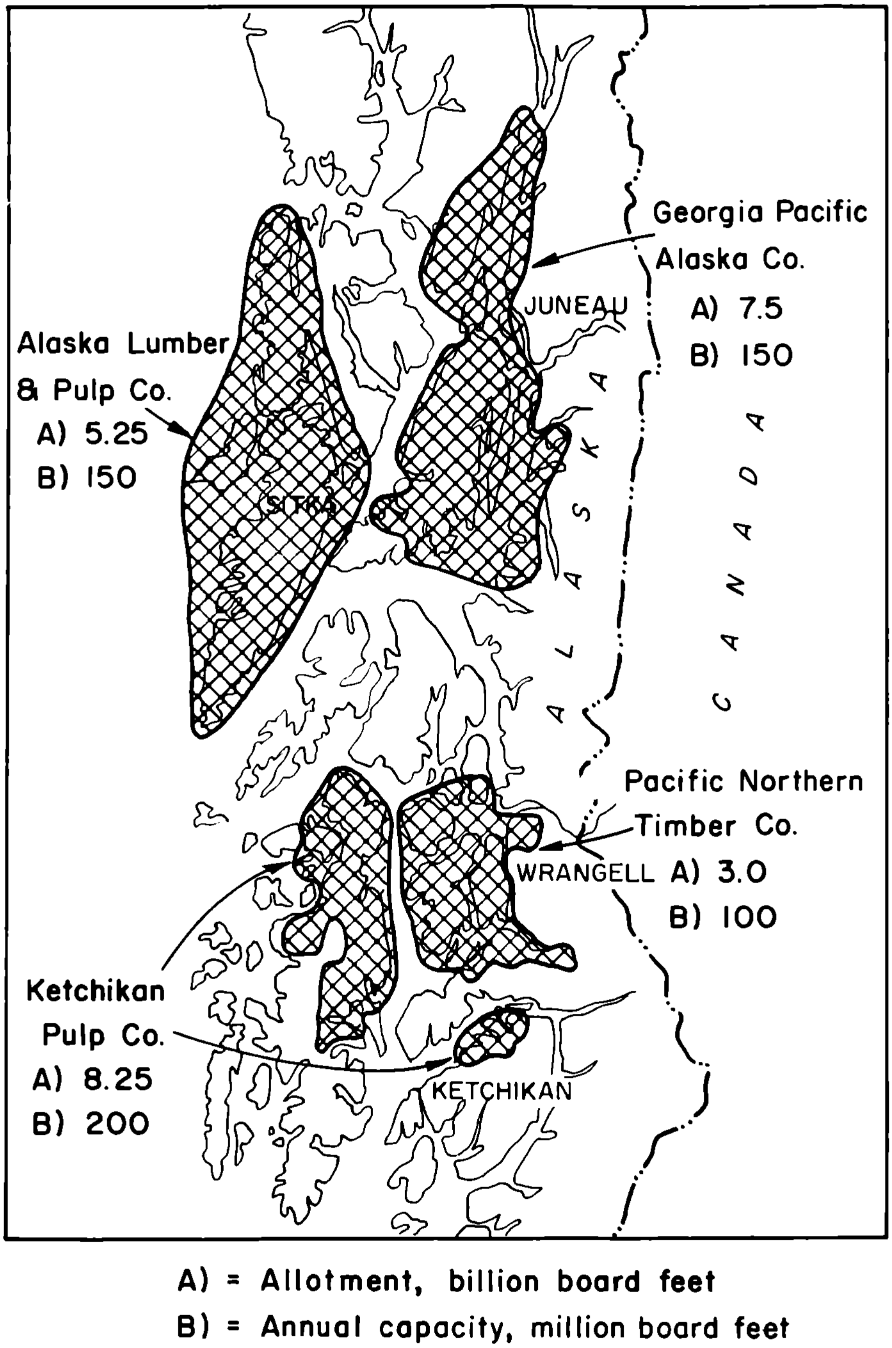

FIGURE V-24. TIMBER ALLOCATIONS FOR PULP-MILL USE

Source: Biennial Report of the Alaska Development Board, 1955-1957

TABLE V-29. PRESENT AND PLANNED USE OF TIMBER FROM SOUTHEASTERN ALASKA (TONGASS NATIONAL FOREST)[a]

Company	Annual Capacity, million board feet
Ketchikan Pulp Company	200
Alaska Lumber and Pulp Company	150
Pacific Northern Timber Company	100
Georgia-Pacific Alaska Company	150
Pulp Use Total	600
Ketchikan Spruce Mills	25
Alaska-Wrangell Mill, Inc.	30
Columbia Lumber (Juneau)	10
Columbia Lumber (Sitka)	10
Metlakatla	10
Alaska Plywood[b]	--
Miscellaneous (all)	15
Lumber Total	100
Grand Total	700

(a) Source: Published data, revised by U. S. Department of Agriculture, Forest Service.
(b) Burned August, 1959, and not rebuilt at this writing.

By 1980, sawmills in the coastal area should be cutting the full input of suitable logs, currently representing about 10 per cent of the pulpwood cut, or about 85 million board feet, although this also may be too conservative. Recent experience indicates that substantially more saw timber might be available. Present Alaskan sawmill capacity is more than sufficient to handle this amount of material without new plant, although of course modernization and larger facilities would lead to more efficient production. If a plywood mill eventually replaces the one destroyed by fire in 1959, about 25 million board feet of suitable veneer logs would be available for plywood use. Lastly, shingle production and use of cedar should account for 40 million board feet, making up the total cut shown in Table V-30.

TABLE V-30. POSSIBLE TIMBER USE, EMPLOYMENT, AND CONSEQUENT POPULATION IN COASTAL ALASKA BY 1980[a]

Use	Raw Material Required, million board feet	Daily Production Capacity	Employment: Logging and Mill Operations	Employment: Service	Employment: Total	Estimated Total Population
Pulp and paper	750	3,000 tons	5,250	5,250	10,500	31,500
Lumber	85[b]	285,000 board feet	390	390	780	2,340
Plywood	25	85,000 board feet	235	235	470	1,410
Shingles and cedar products	40	135,000 board feet	375	375	750	2,250
Total	900				12,500	37,500

(a) Source: "Alaska", U. S. Department of the Interior, Bureau of Reclamation, H.D. No. 197 (January, 1952), p 270.
(b) Modified by Battelle estimate.

Full-scale development of pulp and paper in Southeastern Alaska should result in a total of 10,500 jobs, while forest-industry operations would provide 2,000 jobs. Such employment would be reflected in increased new population, as shown in Table V-30. As the figures in this table include existing pulp and lumber operations, a net increase of 3500 jobs in pulp and paper and 610 in plywood and shingle operations would be added by 1980. Population would increase by 24,660, using a 1 to 6 ratio for jobs to population.

Such a development involves the expenditure of much capital and labor beyond that immediately concerned in the mill. Water and power are prime requisites. The Alaska Lumber and Pulp Company mill requires 35 to 50 million gallons of water a day. The power project necessary to supply the proposed Georgia-Pacific newsprint mill is estimated at $40 million and would produce 290 million kwhr of energy annually, of which 230 million kwhr would be needed by the mill; the balance would be used in the Juneau area. It has been suggested that this obstacle may be overcome by using federal funds to build the power plant.

Transportation needs must take into account the fibrous and chemical inputs to the mill as well as the end-product output. Table V-31 presents estimates of the tonnage involved in the production of 900,000 tons of pulp and paper annually in Southeastern Alaska, of which one-third is newsprint and two-thirds bleached pulp. This rough approximation shows that almost 3 million tons of material would be transported in the manufacture of 900,000 tons of pulp and paper annually. But this would require no new transport facilities of a major kind. The location of the available timber, mostly within 2 miles of tidewater, the use of rail and van barges and tows to supply raw material to the mills and to carry the end product to the railhead at Prince Rupert or Seattle, and the existence and extension of logging roads to enter and log the forest all combine to satisfy the need for transport. According to the U. S. Department of Agriculture Forest Service in Juneau about 5800[48] miles of main logging roads, at the rate of 60 to 65 miles of road per year, would be required to open up the timber stands on the National Forest land. This is divided into 250 miles for the Chugach, 3,286 miles for the North Tongass, and 2,256 miles for the South Tongass. Additional secondary spurs would be required.

TABLE V-31. TONS OF MATERIAL TO BE TRANSPORTED ANNUALLY FOR ALASKAN PULP AND PAPER INDUSTRY, 1970-1980

	For Newsprint, tons	For Pulp, tons	Total, tons
To the Mill			
Pulp Wood	330,000[b]	1,330,000[c]	1,660,000
Chemicals and Supplies	Minor	300,000	300,000
From the Mill	300,000	600,000	900,000
Total Transport	630,000	2,230,000	2,860,000

(a) Based on 300 days of operation per year.
(b) Based on 90 per cent yield.
(c) Based on 45 per cent yield.

If shipment of dissolving pulp to Japan is a forerunner of a major export business to the East, or Latin America, this still can be handled by present or moderately extended water-freight facilities.

There remains to be considered only the interior of Alaska. As noted before, there is no reason to expect that the scattered, relatively inferior, and small-sized timber of this region will be used commercially prior to 1980 except for local needs and perhaps specialized situations of a minor nature. A projection has been made that production of sawn lumber in and for the interior could amount to 12 to 15 million board feet by 1980. Other than this, projected outside needs considered in this study should be satisfied by sources considerably more economical than is interior Alaska at present.

A special case may be the utilization of the birch stands at Knik and Talkeetna, and other nearby points. The Knik stand of 68,000 acres contains about 89 million board feet and the Talkeetna stand of 80,000 acres contains about 100 million board feet. These stands have been explored and re-explored by potential exploiters who successively abandoned the project.

The market for birch in the U. S. has been relatively stable over the past 20 years conditioned not only by demand but by available supply. Production dropped gradually from about 200 million board feet in 1940 to about 160 million board feet in 1957. An additional quantity was imported although import data do not segregate birch from beech and maple. Total consumption in manufactured products of birch from all sources amounted to 284 million board feet in 1958. Of this, furniture, by far the largest end use, accounted for 46 per cent. Containers used 11 per cent, while the balance was spread over two-score end products.

The two major furniture centers for birch are Grand Rapids and Los Angeles. The latter city appears readily accessible from Alaska provided a favorable freight rate applies. Such a rate has been negotiated recently, so that shipping costs dropped from $123.44 to $41.05 per thousand board feet from Talkeetna to Los Angeles. But to be competitive, it appears that a much lower rate must be negotiated or competitive prices must rise. Discussion and some preliminary agreement has been reached on rates of $21 to $24 per thousand board feet to meet marketing conditions in the Los Angeles area.

The quantities involved, however, are quite small. It is estimated that only about 2 to 2-1/2 million board feet of birch are available annually on a sustained basis from the Rail belt area. At 4500 pounds per thousand board feet for birch, an estimated 4500 to 5500 tons per year would be shipped, assuming that markets are found for full-scale production. Adequate transport facilities exist to handle this material to Anchorage and the sea.

In summary, it appears that the full potential of the forest industries in Alaska that can be expected by 1980 may be realized without the need for new highway, rail, or water facilities other than minor extensions to existing facilities.

<u>Canada</u>

The development of the Canadian part of Northwest North America insofar as the forest industries are concerned will in all likelihood be limited to British Columbia and Alberta. The Yukon and Northwest Territories do not hold potential for important development by 1980.

Canada is aggressively pursuing the eventual full development of its northern forests; some consider the northern "spruce belt" to be the answer to increasing competition from the southern pine region of the U. S.[18] These spruce and other timber values are not uniformly distributed over the Canadian section under study. The northwestern and northern parts of British Columbia contain sparse and uncommercial forest land to a great extent; the same is true of northeastern Alberta, although perhaps not to the same degree. It is in the north central and northeast sections of British Columbia and the northwest section of Alberta that the majority of the accessible, relatively rich timber lies.

Over-all, recent studies indicate that production in this region will soar to meet the demands put upon it.[50] Production of saw timber, for example, is expected to double in interior British Columbia by 1980, rising to about 4.5 billion board feet.* Alberta expects that by 1975 the annual drain of forest products will reach three-quarters of the available supply; this will require the utilization of significant volumes of timber from the section of the Province considered in Northwest North America.

Several sites are being actively developed, explored, or proposed for new pulp facilities in this area. One such exploration is by the Grande Prairie Pulp Co. which would be located in or near Grande Prairie, site also of a large plywood mill. Other potential sites in the Alberta part of Northwest North America include the locations between Whitecourt - Lesser Slave Lake, and northwest of Peace River. It is likely that these three pulp mills will become a reality to join the existing and planned ones in the rest of Alberta by 1980.

British Columbia is even more fortunate in the possession of developable sites. A recent publication[27,51] lists eleven sites for pulp mills believed reasonable by the Provincial Government. Of these eleven, four are in the Northwest North American region including the Wenner-Gren British Columbia Development Co. in the Peace River area; Peace River Forest Industries Ltd. in the Fort St. John area; Northern Spruce Co. at Prince George; and Kitimat Pulp and Paper Co. at Kitimat, which, although lying outside the region, is so close that it must be considered.

Following the pattern of integrated forest development which has been set in coastal British Columbia, each of these mills may join or form the hub of a complex producing pulp, saw timber, plywood, or veneer, and possibly particle board.

Transportation will be a major factor in the development of these interior forest resources. Pogue has stated, "the extension of the existing rail route northwesterly from Fort St. John and northwesterly from Prince George would be of great value in this regard as would the lake transportation route offered by the proposed damming of the Peace River."[18]

In Alberta, the Great Slave Lake Railway has been considering two alternative approaches to Great Slave Lake at Pine Point: The West route, originating at Grimshaw, or the East route, originating at McMurray Waterways. There seems little question but that the West route would be preferable from purely a forest-development point of view.[25] Density and accessibility of timber are significantly more favorable in the west.

Present use of the forest is penalized by the lack of rail transport, since lumber must be moved 100 to 180 miles to the railhead at Grimshaw. This lumber is destined

*Virgin timber stands are being acquired by firms like Oregon Pacific Lumber Co., for future development.

for the eastern U. S. and so must be shipped in boxcars for the long haul. This freight penalty has retarded forest use to the point where excess capacity exists in the area. But upon completion of this rail extension, up to 400 per cent expansion in output could occur, generating 240,000 tons of freight per annum for the West route.[25]

The Peace River pulp mill, noted above, is likely to start on a 450-ton-per-day basis, producing sulfate pulp for shipment to Edmonton. At this rate, about 200 tons of chemicals per day (chlorine and salt cake) would be required to produce the pulp for a total traffic of 650 tons per day or, on a 300-day year, about 200,000 tons per year for the West route.

On the same basis, the other two mills, at Grande Prairie and near Whitecourt, would also generate about 200,000 tons of freight each, which will augment the traffic already moving over rail lines serving these cities.

Part of British Columbia is considered tributary to this West route. In 1958-1959, lumber shipments amounted to 3500 carloads or 115,000 tons; this could rise to 15,000 cars or 500,000 tons if the full annual allowable cut were realized. However, it is probably more feasible to expect a 75 per cent utilization, providing 400,000 tons of freight.

To this could be added the tonnage from the proposed Wenner-Gren mill. On the same basis as above, 4000 carloads of pulp and possibly 2000 carloads of chemicals, or about 200,000 tons, would move over rail lines serving the area. The other three pulp mills proposed for this region of British Columbia would not enter into the picture, being supplied from existing facilities or requiring others. In any event, the three could generate a total of 600,000 tons for the region.

Employment and population increases attributable to pulp mills producing 3,150 tons per day (945,000 tons per 300-day year - Table V-32) might amount to 5,510 (logging and mill operations) and 33,060, respectively (using factors employed in Table V-30). Assuming 1.5 tons of finished lumber per 1000 board feet of lumber shipped, the daily production capacity would be about 1,420,000 board feet, as derived from Table V-32. Referring to Table V-30, employment in new Alberta-British Columbia lumber operations would be roughly 6.5 times that estimated for Alaska, or 3,965 in logging and mill operations, for a total population increase of 23,790, attributable to lumber operations. Thus, new pulp and lumber operations would increase population by 56,850.

The total transport deriving from fuller development of the forest industries in the Canadian portion of Northwest North America is estimated in Table V-32. Some of this, as noted above, would move over existing facilities, while in other cases new facilities would be required. This development can be expected by 1980, perhaps as early as 1970.

TABLE V-32. TONS OF MATERIAL TO BE TRANSPORTED ANNUALLY FOR CANADIAN NORTHWEST NORTH AMERICA FOREST INDUSTRY, 1970-1980

Material	Amount to be Transported Annually, tons
Pulp[(a)]	
To the mill	
Pulpwood	2,100,000
Chemicals and supplies	420,000
From the mill	945,000
Total pulp transport	3,465,000
Lumber	
From the mill	640,000
Total	4,105,000

(a) Seven mills assumed, 450 ton/day capacity, 300-day operation, 45 per cent yield.

Summary

Throughout Northwest North America the sheer volume of standing timber of merchantable grade and species is estimated at the impressive total of a trillion board feet. A wide variety of geographic and climatic conditions limits the proportion that is economically accessible at this time. Development of the accessible part in northern British Columbia and Alberta must rest on extensions of rail and highway systems there. Such transportation development, however, is not related to growth of the forest industries in Alaska, where the feasible and likely growth in the two decades to come will be limited largely to the Coastal Forests. Present and ready access already exists for this part of the region in a usable combination of water freight and existing Canadian railways.

The demand for forest products of the type available from Northwest North American forests will condition the growth possibilities inherent in the region. The region as a whole should participate in the increasing world, continental, and local requirements for lumber, plywood, pulp and paper products, but this is not true of each segment of the region. For example, Alaska should benefit by the full development of the Coastal Forest region by 1980. Most of the output of these forests should be utilized in pulp, either dissolving pulp for future chemical conversion, or paper pulp to be made into paper or paperboard elsewhere. Probably a total of 5 or 6 pulp mills will be in operation in Alaska by 1980, producing at the rate of 2500 to 3000 tons daily. There is also a possibility of newsprint being made in this area although the economics do not appear favorable at this time. But the lumber and plywood potential open to coastal

Alaska appears minimal in view of the limitations of distance, suitable sawlogs and species. Only local use is foreseen for the product of interior Alaska to 1980.

A more promising picture can be painted for the British Columbia and Alberta parts of the region under study. Growth into northern British Columbia and Alberta seems inevitable, and there should be an extension northward of the already well-developed lumber, and pulp and paper industries to the south. Huge volumes of relatively accessible, sound wood - depending on feasible new transport installations - combine with increasing world demand to make this a logical proposition. It seems likely that three additional pulp mills in northern Alberta and four in northern British Columbia will be installed by 1980. In addition to daily production of about 3,150 tons from these seven pulp mills it is anticipated that about 2,100 tons of lumber from associated sawmills would be produced daily.

It is not anticipated that either the Yukon or the Northwest Territories parts of the study area will participate in other than local growth within the time period considered.

Over-all, then, and from the point of view of new or major additions to existing transportation facilities in order to promote regional growth based on forest industry, it appears that no such facilities are required to maximize the potential of coastal Alaska, while the installation of such facilities still would not benefit interior Alaska. However, new transport in the way of railways and highways are vital in order to realize the potential of northern British Columbia and northwestern Alberta.

For all of Northwest North America new pulp production, 1961-1980, would develop the major increases in employment and population, with lumber production contributing relatively minor numbers, roughly 20 to 25 per cent. As a result of 2,000 tons of new daily pulp production capacity in Alaska, and 3,150 tons in Alberta-British Columbia, Northwest North America might increase its total population approximately 54,000 by 1980. Associated lumber operations in Alaska would add about 3,600 and in Alberta-British Columbia about 24,000 to the total estimated population. A grand total of 81,600 increase in population, attributable to forest industries would result.

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FISHERIES

Historical Production and Values

The fisheries industry of Northwest North America has been a major source of income to fishermen, processors (canneries, freezers, and packers), wholesalers, cold-storage warehousers, equipment suppliers, and shippers in Alaska and British Columbia for over 90 years. Furthermore, the wholesaling, processing, and retailing of the fish caught in the west coast Canadian and Alaskan waters provide employment and income for many additional U. S. citizens from coast to coast.

Statistical information on the value of landings is often combined with that on canned or otherwise processed fish in discussions of the fisheries industry and its magnitude in the economy of Northwest North America. This practice tends to lead to some misconception regarding the true position of the industry in the economy. In Alaska, for example, the fishing industry has traditionally qualified as the chief source of revenue. However, in recent years the value of forest products has about equaled that of fish when the latter is expressed as "value of catch" rather than as "wholesale value". Wholesale value includes value added by processing, and much of this includes wages to migrant workers and profits to absentee owners so that less of the fishery revenue remains in Alaska than appears on the surface.

Salmon

Of all the fish harvested in Northwest North American waters, the salmon catch has been the greatest in tonnage. From 1940 to 1953 there was a steady decline in the quantity of salmon caught by Alaskan fishermen (Figure V-25); the annual catch from 1953 to 1958 has leveled off to between 200 to 260 million pounds. British Columbia's catch has fluctuated considerably in tonnage from 1940 to 1958, as shown in Figure V-25 although it has not shown the absolute decline indicated for Alaska. Also, as shown in Figure V-25, total value of the catch increased until 1949 when for the next 8 years it leveled off in the $20 to $30 million range for Alaska; the British Columbia catch was in about the same range during this period, but soared to 37 million in 1958.

The apparent wide discrepancy between values-to-tonnage ratios for total Alaska and British Columbia salmon catch may be explained by the higher proportion of sockeye and coho (high-value species) in British Columbia's catch in a given year and the overall higher price usually received by fishermen for all types of British Columbia salmon versus Alaskan, year after year. However, where there are exceptions to this rule, as can be seen in Table V-33, these may be attributed to supply and demand. An exceptionally good year in quantity of salmon caught can cause a market glut that has a depressing effect on prices paid to fishermen as a whole, or in the area where the catch is abnormally high. It is also probable that the extensive use of company-owned fish traps in Alaska had a depressing effect on the prices paid to fishermen there. British Columbia fishermen using their own equipment could command higher prices for their catch.

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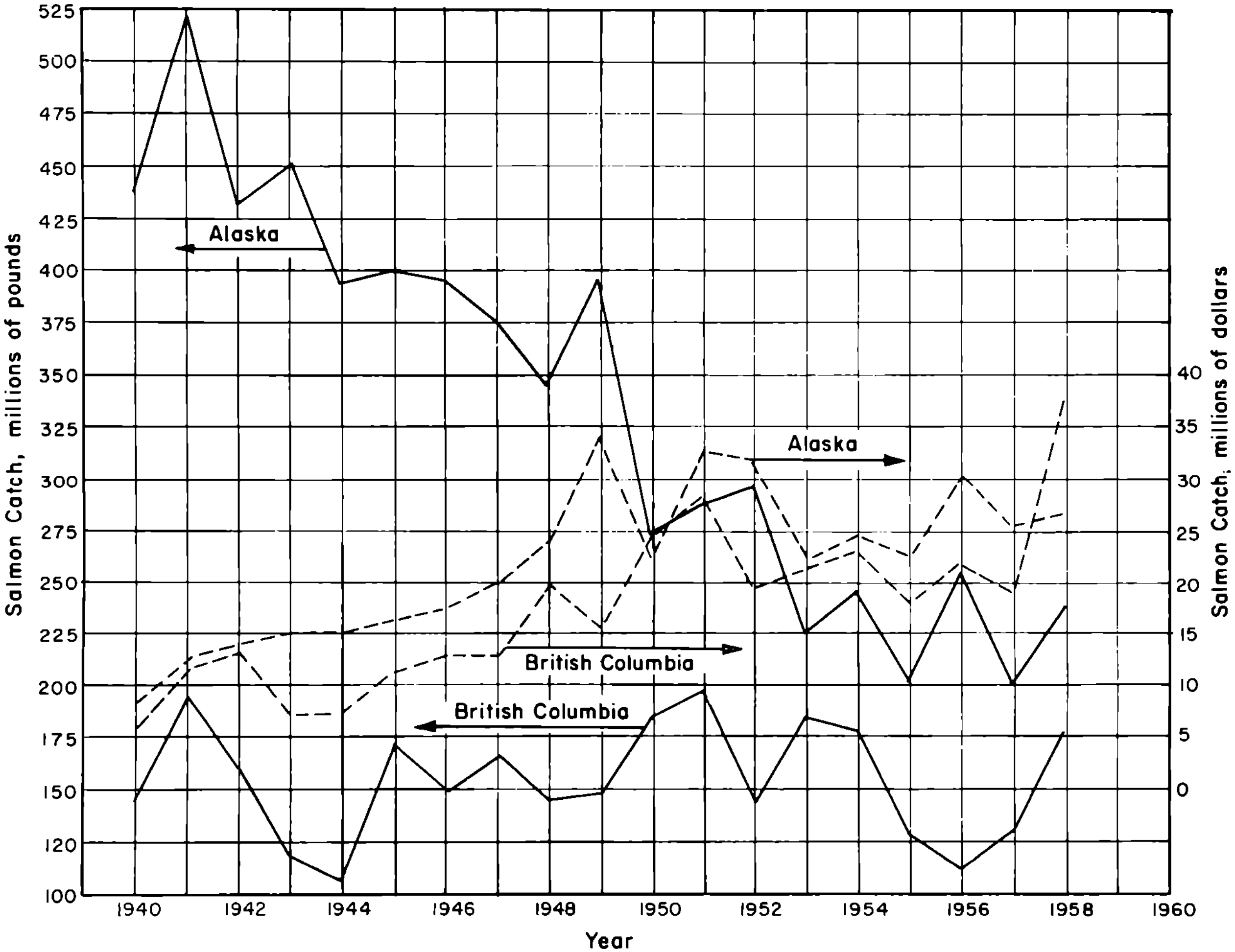

FIGURE V-25. COMPARATIVE SALMON CATCH, ALASKA AND BRITISH COLUMBIA, 1940-1958

Although Canadian/U. S. dollar relationship has fluctuated over a 15¢ range, it is apparent that this factor accounts only in a minor way for the vast difference in value of catch.

TABLE V-33. COMPARATIVE CATCH, LANDED AND MARKETED VALUES OF FOUR SALMON SPECIES FOR ALASKA AND BRITISH COLUMBIA, 1957 AND 1958[(a)]

Species		Catch, millions of pounds	Landed Value, millions of dollars	Landed Value, cents per pound	Sales of Canned Salmon[(b)], millions of pounds	Marketed Value, millions of dollars	Marketed Value, cents per pound, of Market Product (Canned)
				1958			
King or spring	Alaska	10.9	3.03	27.5	2.5[(c)]	1.54	61.5
Chum	British Columbia	14.2	4.02	28.3	0.5[(c)]	0.24	48.0
	Alaska	61.7	4.21	6.9	36.5	12.79	35.0
	British Columbia	38.1	3.75	9.8	11.1	3.79	34.0
Pink	Alaska	120.7	11.05	9.0	75.2	32.50	43.0
	British Columbia	33.9	3.15	9.3	21.7	9.40	43.0
Sockeye	Alaska	34.6	6.34	18.4	23.5	16.50	70.0
	British Columbia	74.1	20.78	28.0	51.5	41.20	80.0
Coho	Alaska	13.1	2.22	17.0	4.9	2.74	5[illegible].0
	British Columbia	24.7	5.38	21.8	6.3	3.99	63.3
Totals	Alaska	241.3	26.85	11.1	142.6	66.13	[illegible]6.5
	British Columbia	185.5	37.08	20.0	91.1	58.62	64.3
				1957			
King or spring	Alaska	10.3	2.20	21.3	2.3	1.53	66.0
Chum	British Columbia	12.7	3.00	23.8	0.5	0.24	48.0
	Alaska	66.2	5.34	8.0	39.8	15.34	38.3
	British Columbia	27.2	2.43	8.9	11.5	4.49	39.0
Pink	Alaska	54.1	5.88	11.0	35.3	16.94	48.0
	British Columbia	57.3	5.37	9.4	36.1	15.76	43.5
Sockeye	Alaska	58.4	9.51	17.0	36.6	26.69	73.0
	British Columbia	15.7	4.43	28.1	10.9	9.26	85.0
Coho	Alaska	14.4	2.11	14.5	4.2	2.39	57.1
	British Columbia	22.8	3.63	15.9	9.3	5.49	59.0
Totals	Alaska	203.4	25.04	12.3	118.2	62.91	53.2
	British Columbia	135.7	18.86	13.8	68.3	35.24	51.0

(a) Source: "Alaska Fisheries", Fish and Wildlife Service Bulletin (1957 and 1958). "Commercial Salmon Fisheries of British Columbia", Preliminary Summary for 1958.
(b) Pounds calculated for British Columbia by multiplying cases reported by 48 (pounds per case).
(c) King or spring are marketed principally in frozen or fresh form and prices react sharply to supply and demand in that market.

Other Fish, Shellfish, and By-Products

For Alaska, total tonnage of fish other than salmon has fluctuated between 100 and 200 million pounds for the period 1940-1958, going above 200 million in 1945-1948 and again in 1950. During the period 1940-1958, value rose to $12 million in 1946 and has stayed close to $4 to $7 million since then. As shown in Table V-34, herring catch has accounted for the lion's share of the tonnage, followed by halibut and king crab; halibut has provided most of the value, followed by herring and king crab in that order for most years.

British Columbia catches of herring have been consistently much greater than those for Alaska, with values four to six times as great; halibut landings have been somewhat lower in tonnage than those for Alaska, with values about the same or slightly higher; crab and shrimp landings have been considerably lower in tonnage than those for Alaska, with values also considerably below those for Alaska. These three categories are combined in Table V-35 for 1951-1958. The production of oil and meal from the British Columbia herring catch at least partially accounts for its much greater value ($8 million) than the Alaskan catch ($1 million) in 1958.

Regional Salmon Catch

Figures V-26a and b show graphically the wide fluctuations yearly, 1951-1958, of the salmon catch by major species in Alaska and British Columbia, respectively. The geographical location of statistical fisheries regions and districts in Alaska and British Columbia, respectively, are shown on the accompanying map (Figure V-27). Total catches are shown for major areas as indicated in Figures V-28a through d. Figures V-29a, b, and c show the composition of the salmon catch by species in Southeastern, central, and western Alaska. Figures V-30a through d for British Columbia – Areas 13, 29a and b, 12 and 20, respectively – show the variations by species and year that are typical for major salmon areas. These figures attest to the fickleness of salmon and to the ingenuity and skill of the fishermen in locating as many of the fish as they do.

Canned Salmon and Transportation

British Columbia catches move to market through Prince Rupert or Vancouver, while Alaskan catches (after processing) move through Seattle, Portland, or Prince Rupert. It is doubtful that canned salmon moving to eastern U. S. markets from western or central Alaska would find any advantage in going through a Southeastern Alaska port should highway connections be constructed from the latter to permit trucking through British Columbia. Rail-barge or truck-barge systems utilizing the railheads at Prince Rupert or Seattle would appear to be more logical. Shipments of canned salmon from Southeastern Alaskan canneries might be moved by truck over such a highway if a major proportion of the canning was done at the port or ports connected by the highway. This is contrary to practice currently considered necessary – canning as near as possible to the fishing areas. Otherwise, for Southeastern Alaska, rail-barge or truck-barge movement would probably be preferable, routing through Prince Rupert or Seattle.

TABLE V-34. COMPARATIVE ANNUAL CATCHES OF ALASKAN FISH AND SHELLFISH IN POUNDS AND VALUE, 1948-1957[(a)]

Year	Herring		Halibut		Crab		Shrimp	
	000 Lb	$000	000 Lb	$000	000 Lb	$000	000 Lb	$000
1948	174,449	1,853	34,961	5,095	3,355	159	2,835	227
1949	33,061	414	35,196	5,158	2,634	153	2,268	181
1950	165,367	2,067	38,636	5,776	5,638	368	2,158	173
1951	81,625	1,003	32,045	4,118	7,476	706	1,708	179
1952	45,802	444	33,391	4,554	6,522	719	1,953	182
1953	34,812	452	25,749	2,960	8,085	860	1,734	225
1954	35,322	473	36,075	4,353	11,610	1,126	1,452	189
1955	64,216	794	25,505	2,372	12,547	1,183	1,828	238
1956	103,759	1,280	33,076	4,804	11,242	1,076	3,044	396
1957	118,290	1,478	27,700	3,175	13,638	1,074	2,380	309
1958	88,801	1,069	26,352	3,771	12,957	897	7,802[(b)]	278

(a) Source: "Annual Report", Alaska Department of Fish and Game (1957); "Alaska Fisheries", Fish and Wildlife Service Bulletin (1958).

(b) Prior to 1958, weights were estimated from manufactured weight of processed shrimp.

TABLE V-35. LANDINGS AND VALUES OF HERRING, HALIBUT, CRAB, AND SHRIMP IN BRITISH COLUMBIA, 1951-1958[(a)]

Year	Herring		Halibut		Crab and Shrimp	
	000 Lb	$000	000 Lb	$000	000 Lb	$000
1951	182,716	5,654	20,214	3,429	2,348	184
1952	94,7480	3,201	23,489	3,955	2,824	363
1953	149,120	3,678	24,882	3,661	4,452	508
1954	180,481	4,565	25,200	3,984	5,139	599
1955	152,846	4,187	19,679	2,555	5,602	649
1956	245,698	7,077	23,316	5,067	5,007	591
1957	147,688	4,892	22,647	3,697	4,627	554
1958	202,561	6,712	23,707	4,902	6,117	689

(a) Source: "Fisheries Statistics of British Columbia, 1958" (Preliminary), Canadian Report of Fisheries in Vancouver.

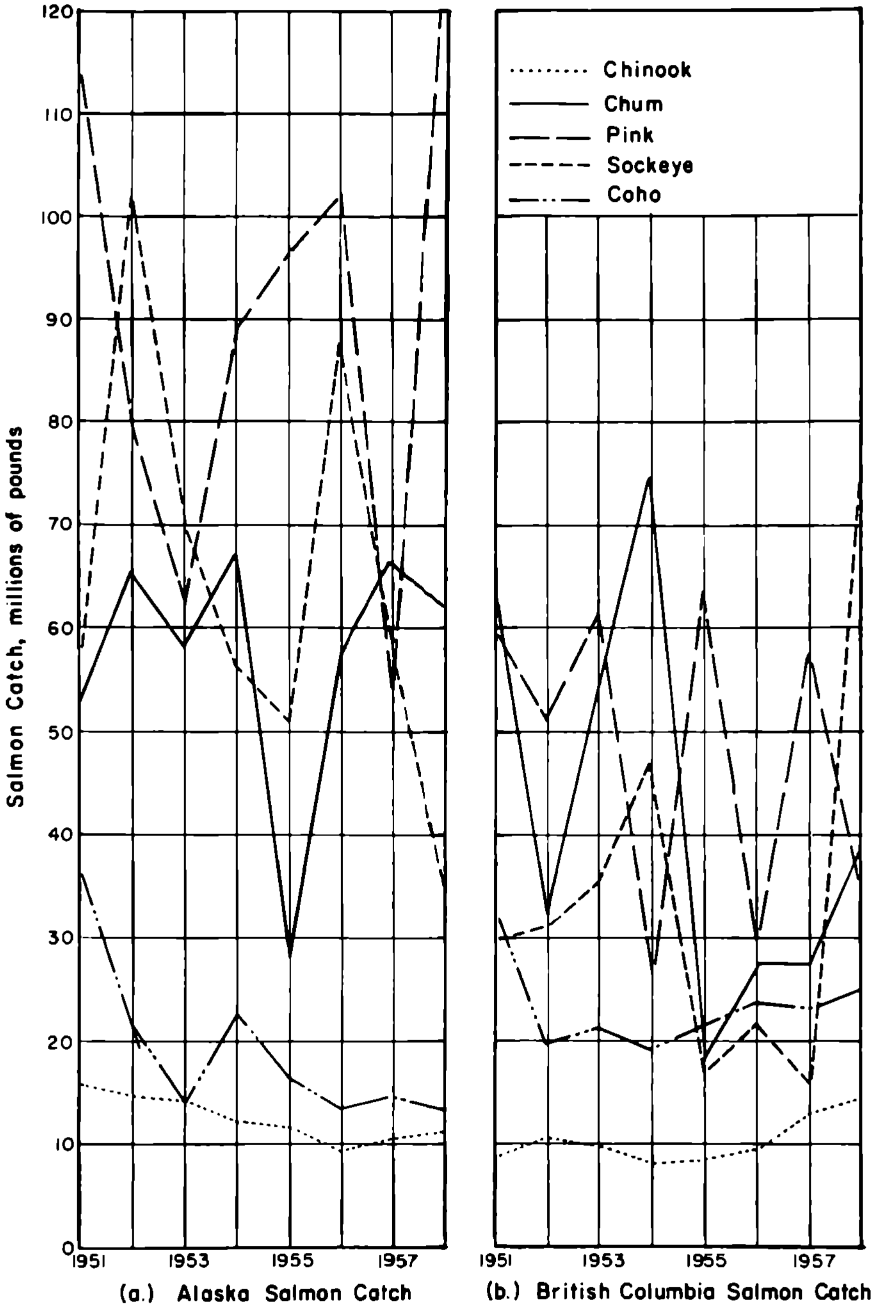

FIGURE V-26. ALASKA SALMON CATCH AND BRITISH COLUMBIA SALMON CATCH, BY SPECIES, IN MILLIONS OF POUNDS, 1951-1958

Source: "Alaska Fisheries", Annual Summary, 1951-1958, Department of the Interior, Fish and Wildlife Service, Branch of Alaska Fisheries; "The Commercial Salmon Fisheries of British Columbia", Statistical Basebook Series No. 3, Department of Fisheries of Canada, 1958; Fisheries Statistics of British Columbia, 1958 (preliminary) Canadian Department of Fisheries, Vancouver (April, 1959).

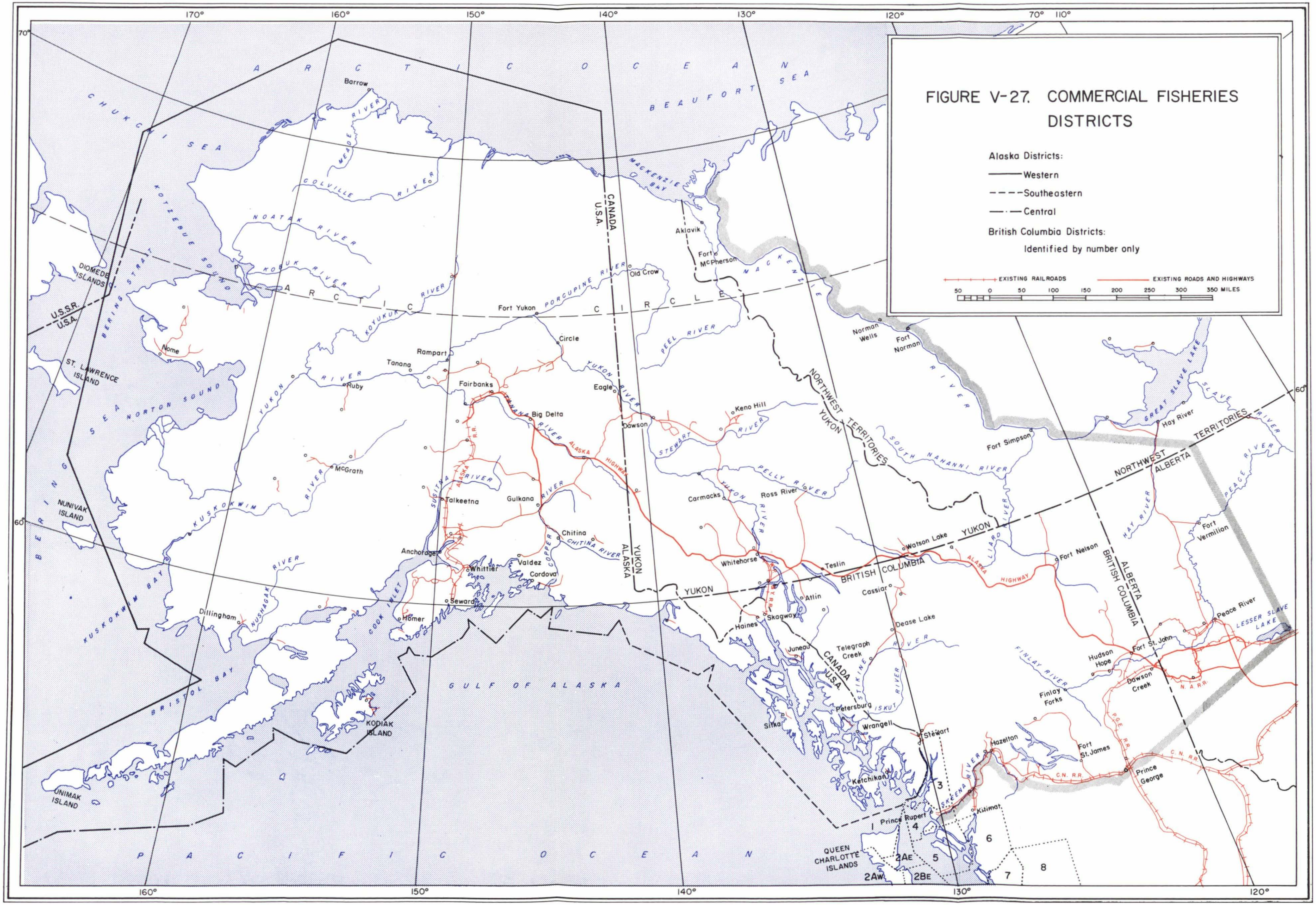

FIGURE V-27. COMMERCIAL FISHERIES DISTRICTS
Alaska Districts:
Western
Southeastern
Central
British Columbia Districts:
Identified by number only
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
GULF OF ALASKA
PACIFIC OCEAN
Barrow
Nome
Fairbanks
Anchorage
Juneau
Whitehorse
Dawson
Ketchikan
Prince Rupert
KODIAK ISLAND
UNIMAK ISLAND
NUNIVAK ISLAND
QUEEN CHARLOTTE ISLANDS
1
2AW
2AE
2BE
3
4
5
6
7
8

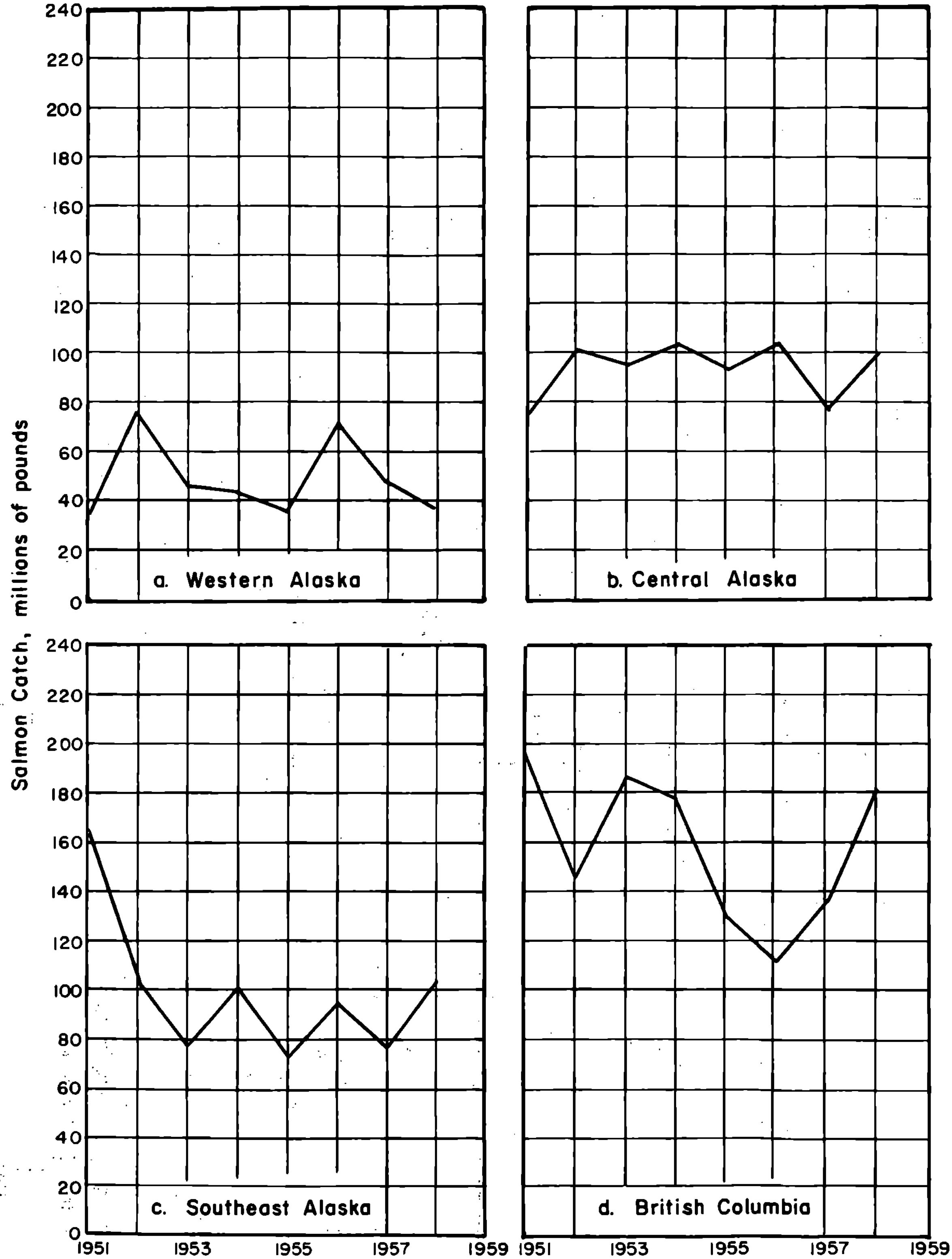

FIGURE V-28. TOTAL SALMON CATCH, ALASKA BY REGIONS, AND BRITISH COLUMBIA, MILLIONS OF POUNDS, 1951-1958

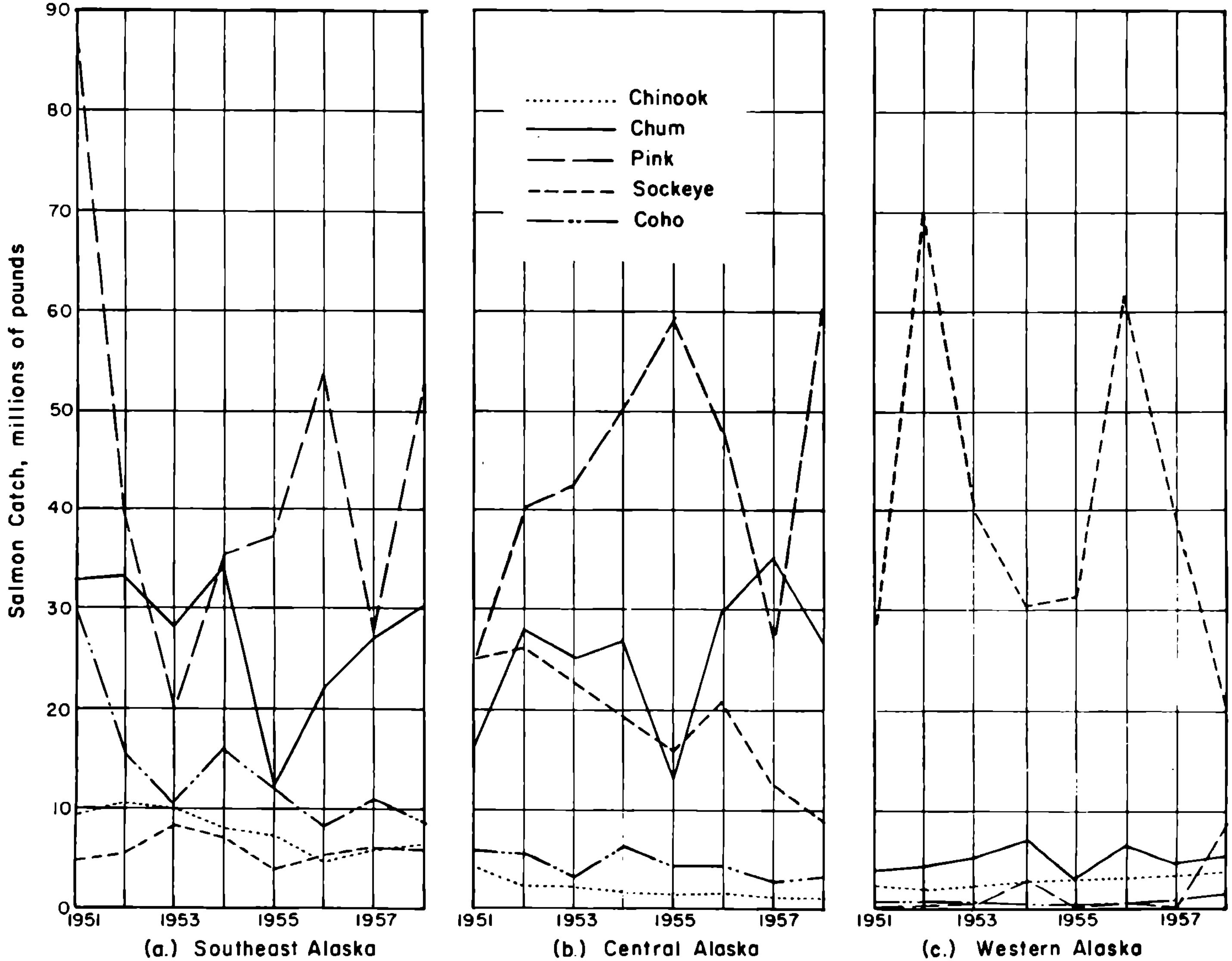

FIGURE V-29. SALMON CATCH IN SOUTHEASTERN, CENTRAL, AND WESTERN ALASKA: ESTIMATED LANDED WEIGHT BY SPECIES, MILLIONS OF POUNDS, 1951-1958

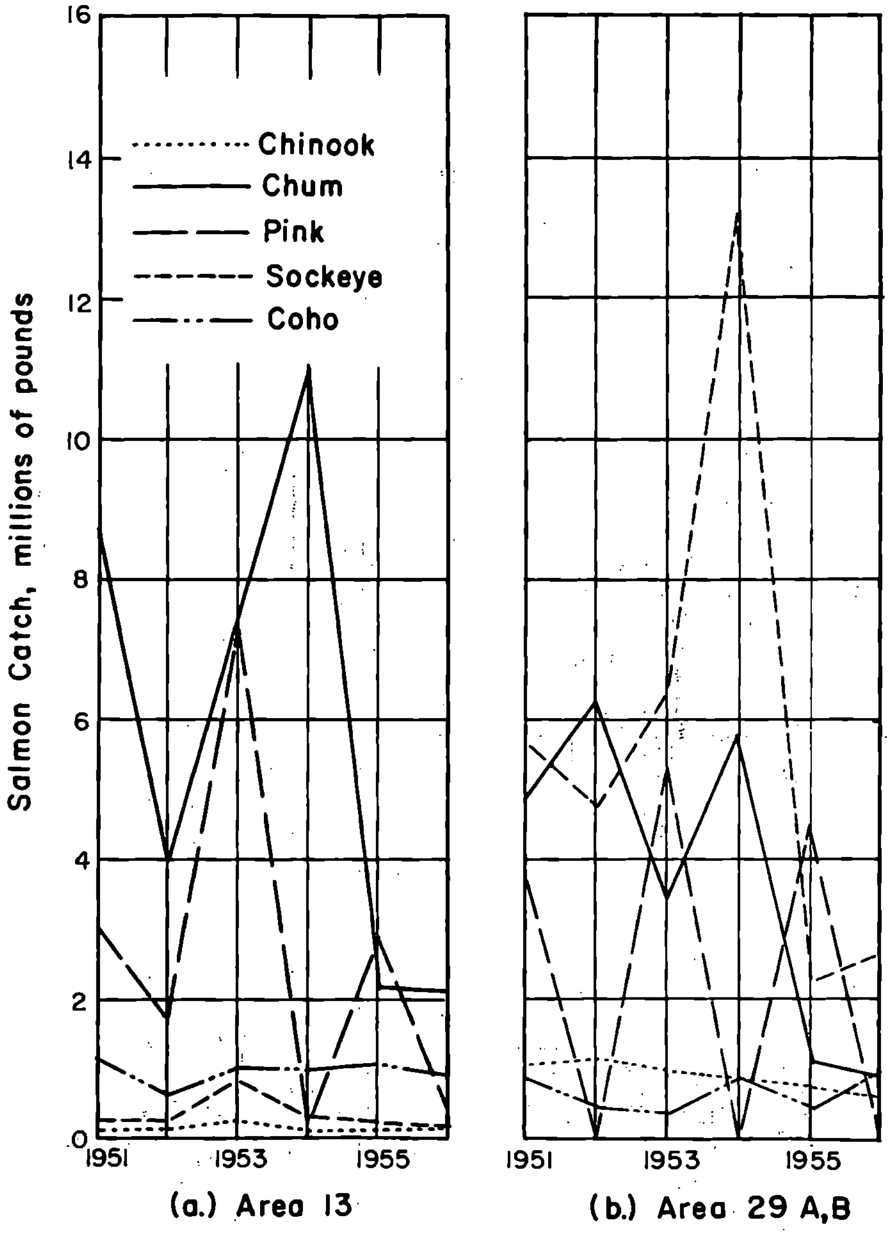

FIGURE V-30. SALMON CATCH IN BRITISH COLUMBIA BY SPECIES AND AREA, MILLIONS OF POUNDS, 1951-1956

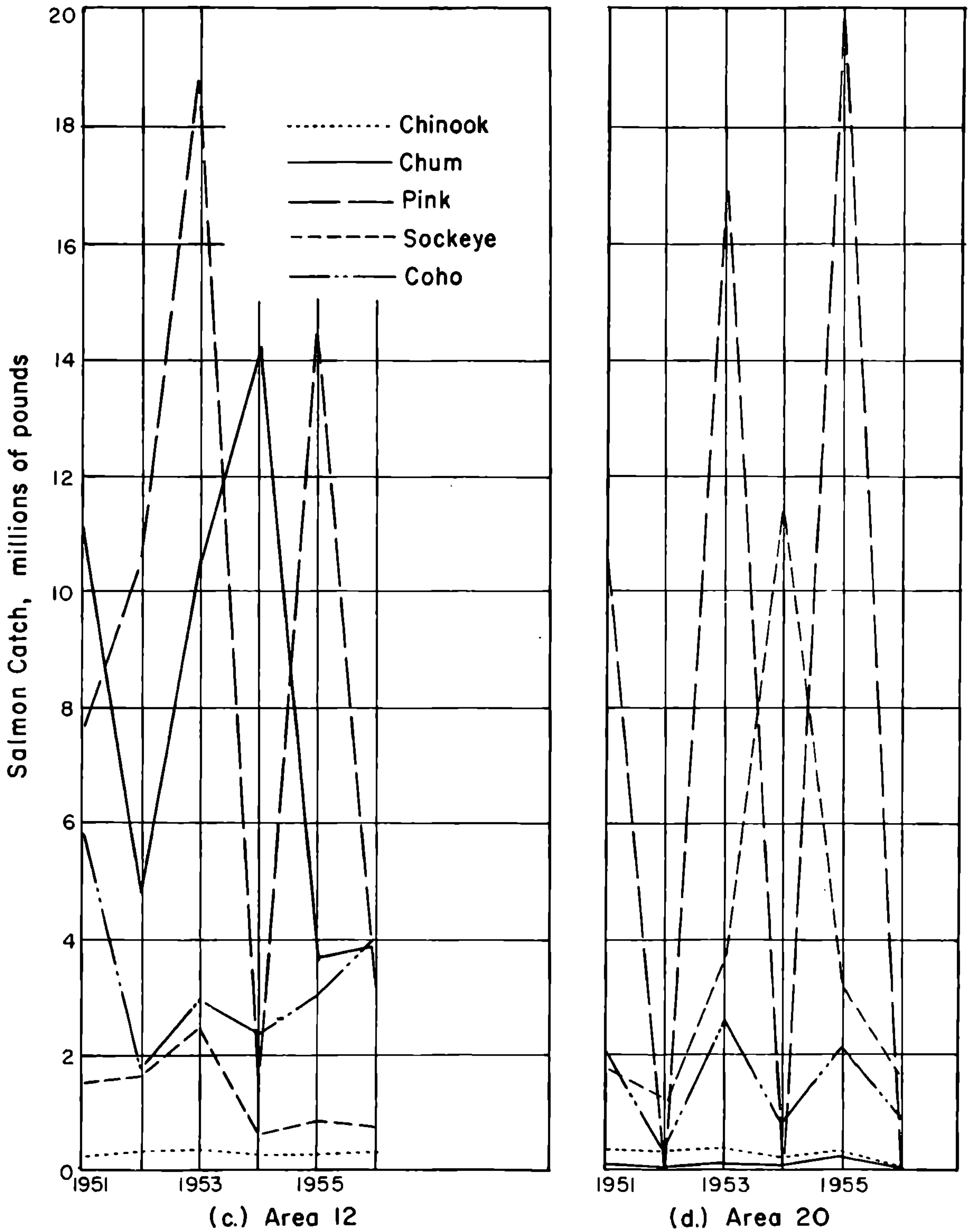

FIGURE V-30. (CONTINUED)

The foregoing discussion hints at patterns of shipping canned salmon that are not actually practiced at the present time. Much of the salmon canned in Alaska is not labeled until it reaches packaging plants in Washington or Oregon. Costs of loading and unloading, movement in and out of packaging plants, and final shipment eastward are incurred. For salmon sold in midwestern and eastern markets, the major consuming areas, shipments of unlabeled canned salmon to packaging plants in these areas direct from Alaskan canneries should show substantial savings below current practice. Carloads of canned salmon moved by rail-barge could move direct to Chicago and New York areas for little more than the rail rate for labeled salmon cans from Seattle or Portland and without incurring the freighting and handling charges between Alaska and the packaging plants in the Pacific states.

In the absence of canned-salmon packaging plants in Chicago and New York, Pacific Coast wholesalers would have to weigh the merits of reducing operations in Washington and Oregon, for example, and setting up similar facilities in the eastern areas. Some might argue that existing labeling and packaging facilities on the West Coast include large volumes of tuna as well as Alaskan and British Columbia salmon, so that the labeling and packaging of the latter are best considered as subsidiary to the tuna operations. A detailed analysis would have to be made by each of the major canned-food companies to determine the relative advantages of the alternative methods proposed. Total poundage of canned salmon, amounting to 142,000,000 pounds in 1958, for example, provides significant opportunity for cost cutting if even one cent per pound savings in handling costs could be found.

Aspects of Fresh- and Frozen-Fish Transportation

Only a small quantity of fresh fish is shipped from Alaska, and most of this is herring for bait. Virtually none of the fish native to Alaskan waters, such as salmon and halibut, is shipped fresh (refrigerated) to Chicago, an important market for which new land transportation routes might be involved. Total shipments of all fresh fish (data not broken down by species of fish or destination) east from Seattle in 1958 amounted to 66 carloads and 9 truckloads.(1)

Frozen-fish production in Alaska – principally salmon, halibut, sablefish and crab – amounts to a fairly sizable tonnage; for example, it was of the order of 40 million pounds in 1958 (Table V-36). The greatest volume consisting of salmon, sablefish, and halibut, originates in Southeastern Alaska, while practically all of the crab come from central Alaska. Table V-37 reveals that slightly over 5.5 million pounds of the major frozen-fish products received at the Chicago market were shipped through British Columbia "in bond" (it is understood that these shipments originated in Alaska). It is apparent, also, from these data that rail freight shipments from Alaska through Prince Rupert, the railhead nearest to Alaska, is the preferred routing at the present time; shipments of frozen fish of British Columbian origin, go exclusively by rail.

In order to consider the possible effect on frozen-fish shipments of new transportation facilities, such as highway connections between Wrangell, Ketchikan and/or Petersburg and the Stewart-Cassiar road and ultimately to trans-Canada and U. S. highways, it is appropriate to look also at shipping practices eastward from Seattle. In 1958, 170 carloads and 351 truckloads of frozen fish were shipped from Seattle to eastern markets; tonnages were about equal, assuming 40-ton carloads and 20-ton

TABLE V-36. PRODUCTION AND VALUE OF FROZEN-FISH PRODUCTS IN ALASKA, BY REGION, 1958[a]

	Southeastern		Central		Western		Total	
	Pounds	Value, dollars	Pounds	Value, dollars	Pounds	Value, dollars	Pounds	Value, dollars
Salmon								
Food	8,508,687	3,671,452	276,177	112,575	171,737	40,329	8,956,601	3,824,356
Bait	14,880	1,488	--	--	--	--	14,880	1,488
Viscera	150,000	9,000	--	--	--	--	150,000	9,000
Herring								
Bait	5,020,115	190,465	--	--	--	--	5,020,115	190,465
Halibut								
Whole	17,464,164	3,904,426	5,078,024	1,060,630	--	--	22,542,188	4,965,056
Cheeks	8,845	3,021	695	173	--	--	9,540	3,194
Livers	209,183	44,563	--	--	--	--	209,183	44,563
Viscera	2,518	75	--	--	--	--	2,518	75
Rockfishes	2,371	153	--	--	--	--	2,371	153
Sablefish								
Food	1,056,336	130,277	--	--	--	--	1,056,336	130,277
Bait	4,777	477	--	--	--	--	4,777	477
Livers	16,630	7,982	--	--	--	--	16,630	7,982
Trout								
Dolly Varden	--	--	7,440	760	--	--	7,440	760
Steelhead	9,250	2,045	--	--	--	--	9,250	2,045
Cod, True								
Bait	12,330	863	--	--	--	--	12,330	863
Crabs, Dungeness								
Whole	7,262	1,960	176,241	35,248	--	--	183,503	37,208
Meat	--	--	52,550	39,412	--	--	52,550	39,412
Cold Packed	142,551	120,440	81,960	61,572	--	--	224,511	182,012
In Sections	--	--	106,218	31,865	--	--	106,218	31,865
King								
Whole	--	--	820,899	328,360	--	--	820,899	328,360
Meat	--	--	1,458,823	1,228,795	--	--	1,458,823	1,228,795
Cold Packed	--	--	28,509	32,164	--	--	28,509	32,164
In Sections	--	--	93,049	41,370	--	--	93,049	41,370
Shrimp								
Whole	36,277	9,641	2,500	500	--	--	38,777	10,141
Cold Packed	377,989	306,588	--	--	--	--	377,989	306,588
Octopus	365	109	--	--	--	--	365	109
Total	33,044,530	8,405,025	8,183,085	2,973,424	171,737	40,329	41,299,352	11,418,778

(a) Source: "Alaska Fisheries", Fish and Wildlife Service Bulletin (1958).

TABLE V-37. SHIPMENTS OF FROZEN FISH TO CHICAGO FROM WASHINGTON AND BRITISH COLUMBIA (IMPORTED AND IN BOND), 1958[a]

Type of Fish	Origin	Weight of Fish, 000 lb, and Method of Shipment: Truck	Rail Freight	Total
Halibut	Washington	927	736	1,663
Sablefish	"	139	15	154
Salmon	"	249	55	304
Crab and crab meat	"	162	343	505
		1,477	1,149	2,626
Halibut	British Columbia (imported)	52	1,969	2,021
Sablefish	Ditto	--	182	182
Salmon	"	15	892	907
Crab	"	Nil	Nil	Nil
		67	3,043	3,110
Halibut	British Columbia (in Bond)[b]	--	4,167	4,167
Sablefish	Ditto	--	76	76
Salmon	"	--	1,337	1,337
Crab	"	Nil	Nil	Nil
			5,580	5,580
Grand Total		1,544	9,772	11,316

(a) Source: "Receipts and Prices of Fresh and Frozen Fishery Products at Chicago 1958", U.S. Department of the Interior, Bureau of Commercial Fisheries.

(b) Predominently from Alaska.

truckloads, or a total of approximately 28 million pounds. It may be assumed that some portion of the frozen fish in these shipments came from Alaska, but with improved transportation facilities this portion, as well as an additional share might be shipped direct from Alaska, bypassing Seattle.

The pattern for British Columbian shipments, Table V-37, might indicate that rail shipments will always be preferred over trucking, since highways to the east from Prince Rupert and Vancouver now exist and are not used for frozen-fish shipments to Chicago. Proposed highways from Alaskan fishing centers would merely connect with these present Canadian highways.

On the other hand, proposed improvements, such as fast ferry service, greater development of van-barge and rail-barge systems, and possibly the Pacific Northern Railroad could permit increased direct shipments from Alaska to the east via "piggy-back" on Canadian railroads. This piggy-back routing could start at (1) Prince Rupert, (2) Hazelton, after highway connections with Alaska fishing centers have been completed, or (3) some point on the Pacific Northern Railroad if and when it and highway connections with Alaska fishing centers have been built. The selection of the route, once several alternatives have been established, and the possible competitive advantages over shipments from Seattle, will rest on comparative costs and service. Assuming optimistically that 30 to 40 million pounds of frozen fish and a modest poundage of fresh fish (refrigerated) would be shipped, 1000 truckloads (20 tons) would contribute to traffic over one or more of the possible routings suggested.

Employment in Fisheries

Employment in the fisheries industry would have a bearing on the needs for improved transportation by virtue of the impact of growth or decline on the economies of the fishing communities and tax revenues to the local, state, and provincial governments charged with construction and maintenance of facilities.

Tables V-38 and V-39 and Figures V-31a and b reveal interesting relationships between fisheries employment and quantities of fish caught by Alaskan (1940-1957) and British Columbian (1940-1956) fishermen. It is notable that, particularly in Alaska, the years of highest catch employed the smallest number of fishermen and the total number of workers has remained relatively high even though salmon catch steadily declined. Other fish species coming into the picture helped to alleviate this situation somewhat. Nonetheless, Figure V-31a, showing ratios between total number of workers employed in fisheries, and million pounds of salmon caught in Alaskan waters reveals dramatically the deterioration in the fisherman's productivity there. The British Columbian picture, as reflected in Figure V-31b and Table V-39, has been one of very little fluctuation in employment with wide fluctuations in the salmon catch.

It seems reasonable to expect fisheries employment in Alaska and in British Columbia to continue the patterns of the past — somewhere in the range of 24,000 to 28,000 for Alaska, close to 17,000 for British Columbia. This assumes no appreciable further decrease in total catch of fish, particularly of salmon.

TABLE V-38. WORKERS EMPLOYED IN FISHERIES INDUSTRY, SALMON CATCH, AND RATIO OF WORKERS TO CATCH IN ALASKA, 1940-1957[(a)]

Year	Number of Workers				Salmon Catch, millions of pounds	Ratio (Number of Workers/ Million Pounds of Catch)
	Fishing	Transportation	Wholesaling and Manufacturing	Total		
1940	10,093	1,651	13,455	25,199	439	57
1941	10,437	1,800	14,787	27,024	543	50
1942	8,564	1,803	12,849	23,216	430	54
1943	9,255	1,605	12,851	23,711	457	52
1944	9 050	1,806	13,809	24,665	393	63
1945	8,261	1,737	13,838	23,836	402	59
1946	10,194	2,011	15,985	28,190	392	72
1947	12,242	1,964	16,091	30,297	382	80
1948	12,371	2,319	16,118	30,767	338	90
1949	10,757	2,194	15,658	28,603	388	73
1950	11,233	2,140	14,171	27,544	265	104
1951	14,097	2,571	14,955	31,623	276	114
1952	14,383	2,852	13,784	31,019	282	110
1953	13,906	2,450	12,277	28,633	220	130
1954	12,444	1,655	8,980	23,079	247	93
1955	13,924	1,639	9,056	24,619	204	120
1956	13,458	1,510	9,581	24,549	270	90
1957	12,203	1,294	9,633	23,130	203	114

(a) Source: "Alaska Fisheries", Battelle computation.

TABLE V-39. WORKERS EMPLOYED IN FISHERIES INDUSTRY, SALMON CATCH, AND RATIO OF WORKERS TO CATCH IN BRITISH COLUMBIA, 1940-1956[(a)]

Year	Number of Workers			Salmon Catch, millions of pounds	Ratio (Number of Workers/ Million Pounds of Catch)
	Fishing	Plant	Total		
1940	10,444	7,443	17,887	143	125
1941	10,217	9,914	18,131	190	95
1942	12,199	6,956	19,155	162	118
1943	11,903	6,011	17,914	121	148
1944	12,463	6,150	18,613	107	174
1945	13,292	6,038	19,330	170	114
1946	13,665	6,079	19,744	150	131
1947	12,491	5,049	17,540	163	108
1948	12,226	4,180	16,406	145	113
1949	12,242	4,220	16,462	147	112
1950	12,159	3,907	16,066	185	87
1951	13,213	4,604	17,817	197	90
1952	13,066	4,049	17,115	147	117
1953	12,449	3,402	15,851	187	85
1954	13,038	3,946	16,984	179	95
1955	12,836	3,415	16,251	131	124
1956	11,851	--	--	114	--

(a) Source: "Commercial Salmon Fisheries of British Columbia", Battelle computation.

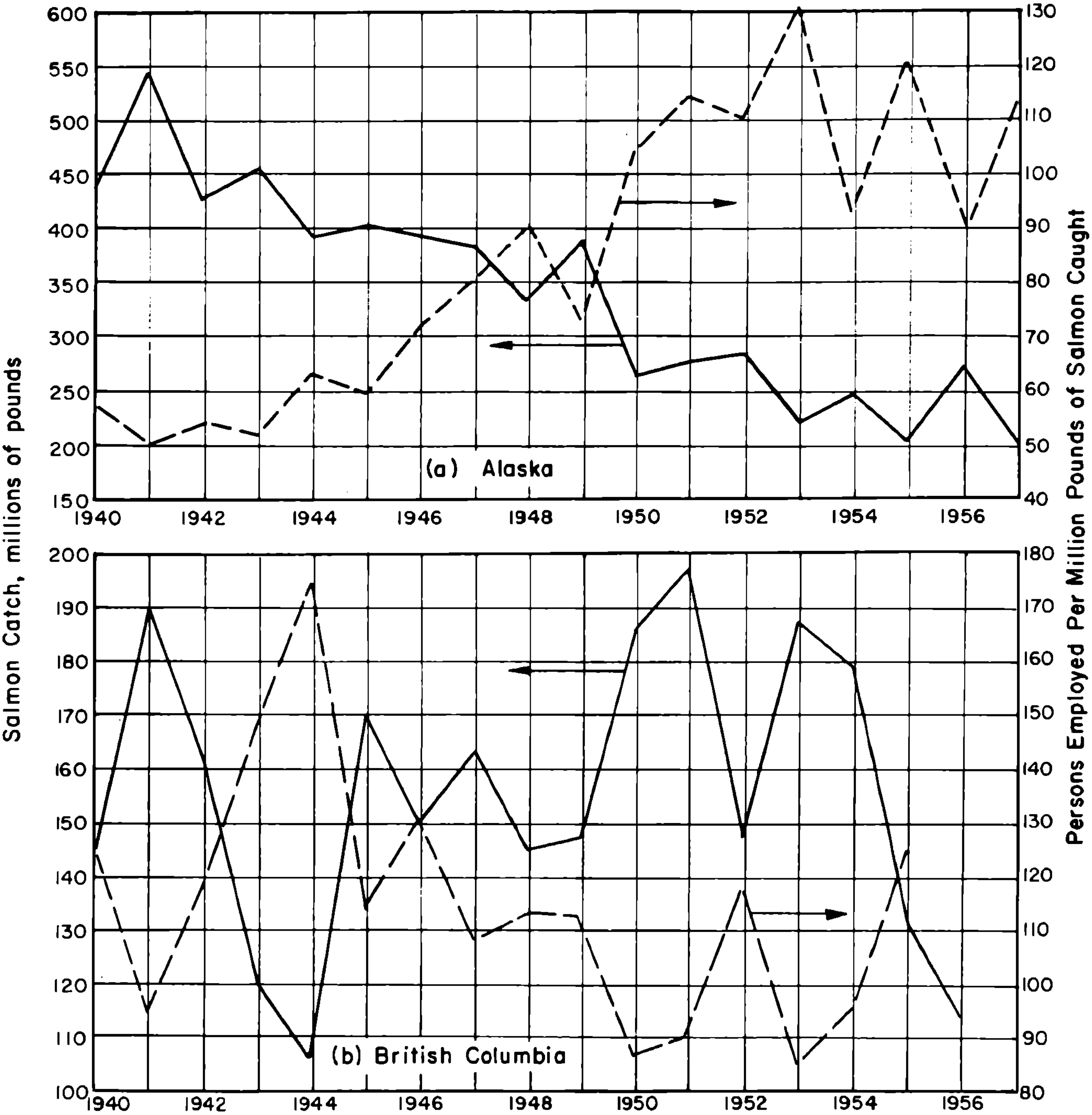

FIGURE V-31. TOTAL SALMON CATCH AND RATIO OF TOTAL FISHERIES EMPLOYMENT TO SALMON CATCH IN ALASKA AND IN BRITISH COLUMBIA, 1940 TO 1956

Source: Commercial Salmon Fisheries of British Columbia; Battelle computation.

Future Status of Fisheries

Although it is beyond the scope of this study to analyze and pass judgment on conservation and control methods in the fisheries, it does not seem remiss to express optimism in the ultimate success of the efforts being made individually and jointly by governments and the industry itself in Alaska, British Columbia, the United States, Canada, and Japan. Russia's future policies, and competition relative to Alaskan fisheries as well as to Japanese deep-sea operations are a potential worry to all concerned.

The fishing industry is featured by a complex of variable factors and conflicting interests that do not lend themselves to simple, quick, or even logical solution. Within the industry itself, competition between types and sizes of gear and boats, and between methods of catching and controlling the catches evokes perpetual debate and controversy. The fish-trap arguments illustrate only one of many problems in this industry.

Differences of opinion are extant relative to what is good or bad for the industry, what is a man-made or a natural cause for fluctuations in a cyclic run of reds, pinks, chum, or coho, and how to devise surer sustained annual catches. Pressures from outside the industry, notably by those interested in hydro-power development and in industrial expansion near or on waterways where salmon runs occur, give the salmon fishermen more to worry about now and in the future.

In spite of these problems, it is difficult to visualize extinction, as some pessimists foresee, of the salmon industry within the next 20 or more years. Likewise, it seems unrealistic to anticipate a return to the high levels attained in years gone by. However, allowing for the effects of constantly expanding knowledge of fish behavior and of the measures required to maintain an optimum balance between natural and man-made influences on fish propagation, the downward trend of the past 20 years in the salmon catch particularly for Alaska should be reversed. The slope of the upward trend line is likely to be more gradual than the downward line has been, becoming almost flat at a sustained annual yield of perhaps 200 million pounds for British Columbia and slightly more than 300 million pounds for Alaska by 1980.

An outstanding, recent example of what research and increased knowledge regarding the fisheries industry can do was the prediction by Dr. William F. Royce, Director of the University of Washington's Fisheries Research Institute, that the run of red salmon in Bristol Bay in 1960 would exceed 30 million fish. Canning companies, fisheries supervisors, and fishermen had difficulty accepting such a large estimate, but they could not afford to ignore it. They made preparations to handle a large run without fully committing men and money to a possibly disappointing operation. An estimated 40 million salmon arrived in Bristol Bay, a run comparable to those in biggest years for this area. After about 15 million fish were caught the canneries could process no more. Because these fish were smaller than usual, total weight of landed salmon amounted to about 72 million pounds.

Species of fish other than salmon may be expected to increase in size of annual catch as greater activity is stimulated by growing markets on the West Coast, by improved transportation facilities permitting faster and cheaper shipment of fresh and frozen fish to markets to the east, by extensive prospecting for all seafoods in boundary ocean areas, and by greater knowledge concerning species that have been receiving more and more attention as salmon catches declined. Recent shrimp discoveries off Cook Inlet are expected to contribute sizable increases to this already rapidly growing segment of the industry.

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Increased catch, particularly of herring and shellfish, might raise total volume for all major species to 590 million pounds for Alaska and 500 million for British Columbia. If relative values similar to 1958 pertain in 1980, this would mean roughly $47 million in value of total catch for Alaska, and $58 million for British Columbia. Table V-40 shows how these estimates were derived and the net increases in pounds and dollars.

TABLE V-40. FISH CATCH IN 1958 IN ALASKA AND BRITISH COLUMBIA AND ESTIMATED INCREASES BY 1980

	Alaska				British Columbia			
	1958		Estimated Increase by 1980		1958		Estimated Increase by 1980	
	Millions of Pounds	Millions of Dollars	Millions of Pounds	Millions of Dollars	Millions of Pounds	Millions of Dollars	Millions of Pounds	Millions of Dollars
Salmon	240	27.0	60	6.6	175	37.0	25	5.0
Herring	89	1.1	100	1.7	200	7.0	50	1.7
Halibut	26	3.7	30	4.5	24	4.9	0	--
Crabs	13	1.0	13	1.0	6 (Crabs and Shrimp)	0.7 (Crabs and Shrimp)	12 (Crabs and Shrimp)	1.2 (Crabs and Shrimp)
Shrimp	8	0.3	8	0.3				
	376	33.1	211	14.1	405	49.6	87	7.9
Total 1980		$47.2				$57.5		

Furthermore, opportunities to move 40 to 100 million or more pounds of salmon-cannery waste for use in animal foods, particularly for mink ranches in the Midwest, should become more realistic as prices of competitive foods (notably horse meat) rise, and lower cost transportation is provided. Much experimental work will be required to firm up this possibility, but indications of potential success have been indicated.[2]

References

(1) "Seattle and Astoria Landings, Receipts and Value of Fishery Products, 1958", U. S. Department of Interior, Bureau of Commercial Fisheries, p 15.

(2) "Potential Markets for Alaska Salmon Cannery Waste", Commercial Fisheries Review (August, 1952), pp 6-12.

FURS

The U. S. is the largest producer and the leading importer of furs, with production elsewhere in the world distributed very unevenly. Extreme fluctuation in fur prices, occasioned by abrupt fashion changes, variations in supply and demand, and a number of other factors, has increased the emphasis on ranch or farm fur raising as opposed to wild fur trapping. Fur farming lends itself to better planning and balancing of supply with demand, and, through the organization of cooperatives, to the control of costs; the more profitable types and quality of furs can be produced.

Until recent years, the value of furs produced in Alaska made the fur industry the third largest industry there. The Pribilof seal rookeries, operated under the supervision of the U. S. Fish and Wildlife Service, have provided roughly 1/2 to 2/3 of the dollar value of Alaska's fur shipments over the past 20 years. Fur trapping and ranching have not been very lucrative, as shown by the following data on value of raw furs shipped in selected years, 1940-1957:

	Fur Seal	Other Furs	Total
1940	$ 964,000	$1,937,000	$2,901,000
1945	2,719,000	1,559,000	4,278,000
1950	2,678,000	1,513,000	4,191,000
1955	6,893,000	1,575,000	8,468,000
1956	5,262,000	1,734,000	6,996,000
1957	7,493,000	Not available	Not available

Harvest of fur seals in the Pribilof Islands has dropped seriously since the record of 123,000 pelts was set in 1956. Ninety thousand skins were taken in 1958, 50,000 in 1959, and about 35,000 in 1960. Reason for the drop is not known definitely, but scientists now suspect that infestations of hookworm have caused it.

In Canada, too, (and northwestern Canada has been no exception) all fur-pelt production has dropped in recent years, with ranch-raised pelts accounting for an increasing percentage of fur values over those for wild furs.

Although it is not too costly to ship raw furs quite some distance, it is extremely helpful to the rancher to have an abundance of relatively low-cost food available reasonably close at hand. Ideal food for mink, for example, is horsemeat or poultry offal; mink farms are often run in conjunction with broiler chicken operations. Where fur farmers have been dependent on horsemeat and the latter has increased in price, due to demand for the latter for dog food, fishmeal and fish waste have grown in popularity as mink food. Needless to say, Alaska and British Columbia canneries produce plenty of fish waste.

Attempts to make a going business of mink ranching in Alaska have obviously failed for reasons other than lack of suitable, low-cost food; such reasons include discouraging prices for furs, inadequate marketing ability or experience, and distance from markets. Fur farming should be as successful an enterprise in Alaska or British Columbia, particularly along the coast, as it is in the midwest and eastern states The cost advantages for the latter are dwindling as the cost of mink food rises; there is serious consideration being given to supplying midwest mink farmers with frozen salmon cannery waste from Alaska. If relatively minor amounts of supplementary foods, to provide some variety in the mink's diet, could be produced in Alaska or obtained at reasonable cost, the availability of large quantities of cannery waste should give the Alaskan fur farmer a cost advantage over eastern farmers.

As has been indicated, however, transportation is not an important factor in fur farming, except as it may be necessary occasionally for producers and brokers or dealers to exchange visits to keep informed of each other's activities. Improved transportation facilities are not an answer to establishing profitable fur farming in Alaska. Neither are they necessary for improving the lot of the fur trappers there. As a supplementary, but major source of income for many northwest North Americans, mostly Indians and Eskimos, fur trapping will continue to provide some income that is unlikely to be increased by any addition to present transportation facilities.

AGRICULTURE

The raising of food in Alaska and northwestern Canada represents a sizable economic activity of people in these areas. Location and extent of production centers are shown in Figure V-32. But while soil and climate limitations to the growing of food in Alaska are not very different from those encountered in northwestern Canada, the greater distance of Alaska to outside markets imposes economic problems upon Alaskan agriculture which are not a major hindrance to the development of agriculture in northwestern Canada. For this reason, agriculture in the two areas will be discussed separately.

Alaska

Farming in Alaska is not a new business. It has a 100-year history. But development of commercial agriculture has come about rather slowly, and has lagged far behind the increase in population. At present, only about 8 per cent of local needs are satisfied from local production, compared to a physically possible degree of self-sufficiency estimated near 50 per cent.

Total value of agricultural production in Alaska in 1959 amounted to $5,124,160. This is less than the average output of agriculture in a prosperous county in the farm belt of the U. S., yet it puts agriculture in fifth place on the list of most important primary natural-resource industries in Alaska.

Past and Present Production

During the past decade, an average of 200 full-time and 350 part-time farmers have been engaged in the production of food. New land is being cleared at the rate of 2000 to 3000 acres per year. But most of this land has to lie idle for 2 to 3 years in order to overcome the natural acidity or permafrost conditions found in newly cleared soil. Thus, although more than 24,000 acres were reported as cropland in 1959, only 17,000 acres were actually used for production purposes.

Detailed production data are available only for the last few years, and even for this period, data are incomplete and often not comparable with figures reported in other years. However, from those available, a slow but steady increase can be noted in the value of farm production as well as in cropland acreage, as shown in Table V-41.

During the past few decades, climate, soil resources, and proximity to local markets have fostered development of six major food-growing areas in Alaska. Table V-42 shows the absolute and relative contribution to total agricultural production of each of these areas in 1959. At the present time, only the first three of the six areas are contributing any significant amount to the food needs of the nonagricultural population of Alaska.

Farm income is derived primarily from five classes of commodities. The relative contribution of these commodities to value of agricultural production and farm income in 1959 is shown in Table V-43.

TABLE V-41. CROPLAND, LIVESTOCK ON FARMS, AND VALUE OF AGRICULTURAL PRODUCTION IN ALASKA, SELECTED YEARS, 1954-1959[a]

	1954[b]	1956[b]	1958	1959
Cropland, acres	13,215	19,636	21,515	24,342
Cereals and Legumes Harvested for Grain	n.a.	14,391[b]	3,484	3,317
Hay and Forages	n.a.		12,248	12,685
Potatoes and Vegetables	1,465	1,384	1,353	1,146
Cleared Land Idle	n.a.	3,861	4,430	7,194
Number of Animals				
Horses	106	n.a.	326	690
Cattle	5,160	5,550	5,799	6,647
Sheep	9,183	12,376	10,787	13,573
Hogs	589	977	886	1,340
Chicken	31,350	30,037	34,106	47,363
Reindeer	n.a.	n.a.	49,000	50,400
Value of Commercial Production, dollars	2,664,770	3,169,090	3,350,113	3,512,405
Value of Home and Farm-Use Products[c], dollars	213,182	1,061,225	1,325,876	1,611,755
Total Value of Agricultural Production[d], dollars	2,877,952	4,231,134	4,675,989	5,124,160

(a) Source: U.S. Census of Agriculture 1954, Volume III, Part 3 "Alaska". "Farm Production", Alaska Department of Agriculture and Alaska Agricultural Experiment Station, Palmer, Alaska (1957, 1959, and 1960).

(b) n.a. = not available.

(c) 1954 data not comparable.

(d) Includes hay and forages.

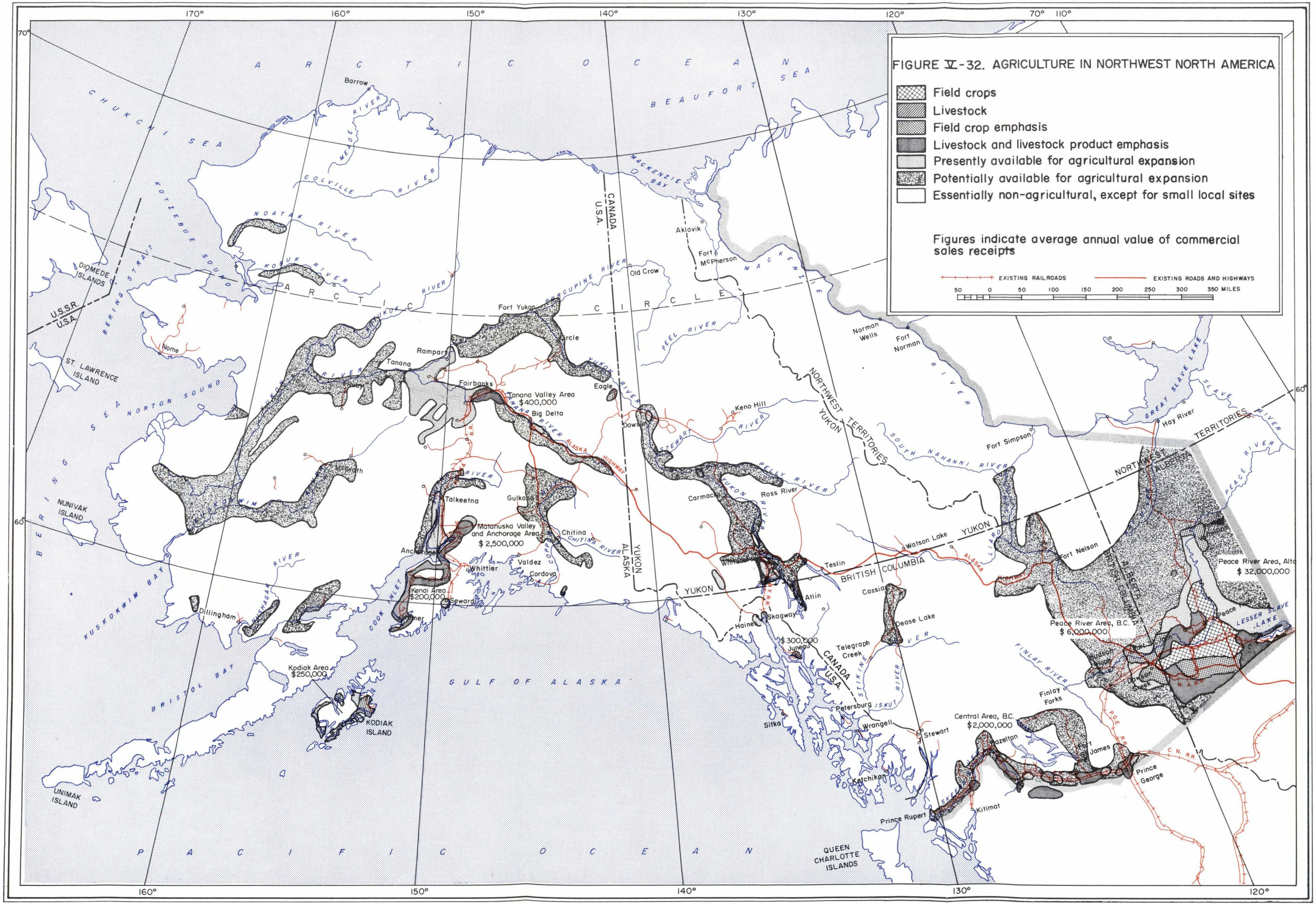
FIGURE V-32. AGRICULTURE IN NORTHWEST NORTH AMERICA
Field crops
Livestock
Field crop emphasis
Livestock and livestock product emphasis
Presently available for agricultural expansion
Potentially available for agricultural expansion
Essentially non-agricultural, except for small local sites
Figures indicate average annual value of commercial sales receipts
EXISTING RAILROADS
EXISTING ROADS AND HIGHWAYS
50 0 50 100 150 200 250 300 350 MILES
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
GULF OF ALASKA
PACIFIC OCEAN
Barrow
Nome
Fort Yukon
Circle
Rampart
Tanana
Fairbanks
Tanana Valley Area $400,000
Big Delta
Eagle
Dawson
Aklavik
Fort McPherson
Old Crow
Keno Hill
Norman Wells
Fort Norman
Fort Simpson
Hay River
McGrath
Talkeetna
Gulkana
Matanuska Valley and Anchorage Area $2,500,000
Chitina
Valdez
Cordova
Whittier
Kenai Area $200,000
Seward
Dillingham
Kodiak Area $250,000
KODIAK ISLAND
Carmacks
Ross River
Whitehorse
Teslin
Watson Lake
Atlin
Cassiar
Skagway
Haines
Juneau
$300,000
Telegraph Creek
Dease Lake
Fort Nelson
Peace River Area, Alta. $32,000,000
Peace River Area, B.C. $6,000,000
Finlay Forks
Central Area, B.C. $2,000,000
Hazelton
Fort St. James
Prince George
Stewart
Kitimat
Prince Rupert
Ketchikan
Wrangell
Petersburg
Sitka
QUEEN CHARLOTTE ISLANDS
NUNIVAK ISLAND
ST. LAWRENCE ISLAND
DIOMEDE ISLANDS
UNIMAK ISLAND
U.S.S.R.
U.S.A.
CANADA
YUKON
ALASKA
BRITISH COLUMBIA
NORTHWEST TERRITORIES
ALBERTA
ARCTIC CIRCLE
ALASKA HIGHWAY
YUKON RIVER
GREAT SLAVE LAKE
LESSER SLAVE LAKE

TABLE V-42. TOTAL VALUE OF AGRICULTURAL PRODUCTION BY AREA, ALASKA, 1959[a]

Area	Value, dollars	Per Cent of Total
Matanuska Valley	3,092,921	60.36
Tanana Valley	663,165	12.94
Anchorage	415,578	8.11
Kenai Peninsula	276,293	5.39
Kodiak and others	339,618	6.63
Southeastern Alaska	336,585	6.57
Total	5,124,160	100.00

(a) Source: "Farm Production, Alaska - 1959", Alaska Division of Agriculture, and Alaska Agricultural Experiment Station, Palmer, Alaska (1960).

TABLE V-43. MAJOR CLASSES OF FARM PRODUCTS CONTRIBUTING TO TOTAL VALUE OF AGRICULTURAL PRODUCTION AND FARM INCOME, ALASKA, 1959[a]

Product	Total Value of Agricultural Production		Farm Income From Cash Sales	
	Dollars	Per Cent	Dollars	Per Cent
Milk	1,878,156	36.65	1,771,076	50.44
Potatoes	588,956	11.50	577,846	16.45
Eggs and poultry	502,213	9.80	444,908	12.67
Beef, pork, mutton, reindeer	427,525	8.34	341,308	9.72
Vegetables	303,900	5.93	264,110	7.53
Wool and furs	112,157	2.19	112,157	3.19
Grain and straw	253,003	4.94	--	--
Hay and silage	1,058,250	20.65	--	--
Totals	5,124,160	100.00	3,512,405	100.00

(a) Source: "Farm Production, Alaska - 1959, Alaska Division of Agriculture, and Alaska Agricultural Experiment Station, Palmer, Alaska (1960).

Physical quantities represented by these values are shown in Table V-44.

TABLE V-44. VOLUME OF MAJOR AGRICULTURAL COMMODITIES PRODUCED AND SOLD, ALASKA, 1959[a]

Product and Unit	Produced	Sold
Milk, lb	16,855,574	15,792,831
Eggs, doz	553,468	498,999
Poultry meat, lb	67,792	46,179
Beef, lb	359,286	305,890
Pork, lb	225,000	189,150
Mutton, lb	30,500	9,100
Reindeer, lb	439,500	336,117
Potatoes, tons	5,396	5,183
Vegetables, tons	1,030	904
Wool, lb	113,012	113,012
Fur, pelts[b]	2,000	2,000
Grain, cwt	45,740	--
Hay, tons	8,590	--
Straw, tons	1,377	--
Silage, tons	25,961	--

(a) Source: "Farm Production, Alaska - 1959", Alaska Division of Agriculture, and Alaska Agricultural Experiment Station, Palmer, Alaska (1960).

(b) Farm production only.

Resources

Authoritative reports on soils and climates in Alaska indicate that the physical limitations resulting from availability of suitable land and those imposed by local climates are not an absolute barrier to substantial expansion of agriculture. However, these physical impediments do increase production costs and put the Alaskan farm economy at an economic disadvantage relative to the farm economies of other states.

Land. Only one of the several zonal soil groups occurring in Alaska, namely that of the brown forest soils, has proved suitable for continued commercial agricultural production. Well-drained phases of this subarctic brown forest soil, as well as some alluvial soils also suitable for cropping, are found in large and small areas as far north as the Arctic Circle. They are high in potash content, but deficient in organic matter, nitrogen, and available phosphates. While subsoils seem well supplied with calcium and magnesium, surface layers are often acid.

Early appraisals of the total acreage in Alaska suitable for cultivation (variously estimated as high as 200 to 300 million acres — almost the total acreage of Alaska!) have been revised drastically as accessibility and availability of better soils elsewhere in the U. S. have been taken into consideration. Authoritative data published now indicate that, under anything like present economic conditions, the total area of soils suitable for cropping in Alaska is less than 1 million acres. Possibly another 3 million acres would be usable for summer pasture in conjunction with cropland.[1]

The 1-million-acre estimate includes only lands already surveyed, and located in or near present settlement areas. This is all that can rightfully be included under the conditions of relative abundance of tillable acreage expected to prevail in the U. S. for the next decade. Even so, the 24,342 acres of Alaskan cropland reported in 1959 represent only a small fraction of the total mobilizable land resource in Alaska, should markets for additional agricultural products open up. Location of potential acreage is shown in Figure V-32.

Other regions, also reported to contain scattered agricultural lands, but presently inaccessible, unexplored, or within limited markets, are also shown in Figure V-32. These areas may contain another 15 to 20 million acres of suitable soils, but are not foreseen to come into production within the next several decades, for the reasons just indicated.

Production problems posed by Alaskan soils can be serious. Initial acidity of newly cleared land as well as poor drainage of the fields may prevent cropping the land for 2 to 3 years after it is cleared. In central Alaska, melting of large blocks of solid ice under the soil surface may render already cultivated fields untillable.

Costs of clearing new land range from $50 to $200 per acre. By the time a home and barn are built, and machinery, animals, and equipment are purchased, $65,000 and 10 years of hard labor may be invested in a tract which, owing to the present 160-acre homestead limit, generally proves to be too small for successful commercial production. Additional adjoining land often is not available for purchase.

Upward revision of the 160-acre homestead limit is presently under consideration. However, availability of credit for expansion, the second most important prerequisite for the development of efficient production units, is still limited. Under these handicaps and present economic conditions, development of new farms remains at best a risky business.

Climate and Types of Farming. Climatic factors apparently impose more of a limit upon specific areas within Alaska than upon agricultural production in the aggregate. For the State as a whole, climate does not appear to be an obstacle to expanded production of any food that can be grown economically in temperate regions of the continental U. S. However, availability of suitable and adapted crops and livestock breeds has favored some enterprises more than others. In addition, local differences in the length of the growing season, annual precipitation, and winter temperatures, have made for some specialization of production in the various agricultural areas.

Farmers in Southeastern Alaska are forced by the high annual precipitation to concentrate mainly upon dairying, raising vegetables, fruits, and berries. On Kenai Peninsula and on Kodiak Island, where precipitation also is high, livestock enterprises have become the chief specialty.

Settlers in the Anchorage area and in the Matanuska Valley find themselves favored with both soil and climate suitable for a diversity of agricultural enterprises. The shorter growing season necessitates a longer barn-feeding period for cattle, but this disadvantage (compared with the Alaska Peninsula and islands farther south) is fully compensated by the easier accessibility of the Matanuska Valley and proximity to local markets.

The Tanana Valley, northernmost of the production centers and close to Fairbanks, has the most severe winter temperatures and the shortest growing season. However, summers are mild enough to permit the growing of hardy grains, and the keeping of some livestock.

Crop yields compare favorably with those reported in other states. New varieties of oats and barley, introduced during the last decade, bring forth equal or better yields than the same grains in the continental U. S. In fact, return per acre from these feed grains exceeds that realized from the production of wheat. Consequently, little wheat is grown in Alaska at this time.

Potato production, favored by physical as well as economic factors, has been expanded to the capacity of the local market. Vegetables grow luxuriantly during the long hours of daylight in midsummer. Forages, especially oat-pea mixtures, provide pasture, hay, and silage for livestock.

Among the various livestock enterprises, dairying has become the chief source of income of Alaskan farmers, especially of those in the Matanuska Valley. Beef production, based on extensive grazing and the feeding of silage, is concentrated on Kodiak. Sheep production also is effectively limited by climatic considerations to Kodiak and other islands. Hogs are being successfully fed on garbage and grain in the Anchorage area.

Reindeer, which suffered a rapid and alarming decline in numbers a few decades ago, have responded well to better herding and management practices. Reindeer raising now provides not only the native Eskimos but also some central markets in the cities with additional meat.

Marketing, Processing Facilities, and Sources of Supplies

Up to now, the small volume of local production has inhibited development of an efficient marketing system and establishment of any significant food-processing industries. The one flour mill in operation some 25 years ago had to shut down a few years later because of uncertainty of supply. So far only the small local dairy plants, slaughtering houses, and bakeries have been able to survive. Canneries specialize in fishery products only. No other food-processing industries exist.

Most agricultural products are marketed through two or three local cooperatives which operate small dairy plants, produce departments, a grain elevator, slaughtering houses, and a meat department. For the average farmer, these cooperatives also represent the main source of his supplies. Fertilizer, machinery, livestock feeds, and building supplies all must be imported, since Alaskan agriculture thus far is too small to support such industries locally.

Future Prospects for Alaskan Agriculture

No northward expansion of our complex technological civilization can expect to be supported entirely by foodstuffs grown within the subarctic. Modern immigrants to the north are conditioned to an abundant and varied diet including vegetable fats, oils, sugar, a variety of grain products, legumes, fruits, nuts, tobacco, coffee, out-of-season vegetables, and other things that make up perhaps half of the bulk and about half of the typical family's grocery bills. These components of a modern diet cannot be grown economically in Alaska on account of soil and climate limitations. This cuts a considerable slice out of the local market for homegrown foodstuffs.

There remains, however, somewhat less than half of a modern household diet which can be produced on favorable sites in Alaska, consisting of products such as milk, meat, eggs, potatoes, cereals, vegetables, and some fruits. But even in the production of these, Alaska is handicapped, mainly because nearly all agricultural supplies must be shipped in. Consequently, costs of production of Alaskan agriculture are high, higher than in any other center of commercial agriculture on the North American continent. Even a sizable reduction in transport charges for inshipment of agricultural supplies from the Pacific States to Alaska will not alter this fact.

Under these conditions, combined with the high cost of new farm development and a general lack of credit for a quick expansion of existing operations, any significant increase in the self-sufficiency of Alaska in the production of food will come about rather slowly. This means that the amount of inshipments of food, measured in tons, will not decrease. Total tonnage of imports will not be affected greatly by the possible establishment of small local freezing or cannery operations for vegetables or other perishable products produced in Alaska. At present, between 80,000 and 100,000 tons of food are imported annually. Should, for example, the civilian population reach an assumed level of 300,000, during the next decade, the 50 per cent of food products that must always be imported from regions with a more moderate climate would still amount to approximately 100,000 to 150,000 tons per year.

The present rate of expansion of Alaskan agriculture cannot be speeded up drastically by any improvement of existing, or addition of new, transportation facilities between the Pacific States and Alaska. In fact, such new developments may temporarily slow down the rate of growth, due to cheaper imports of food. Improvement of transportation facilities would not affect the decision to abstain from the use of such cost-increasing production methods as irrigation, hydroponics, or artificial drying of forages in Alaska. Nor will it permit a drastic increase in any of the livestock enterprises based on increased imports of feed grains and roughages for winter feeding. Finally, improved transportation facilities cannot be expected to make profitable the initiation and development of new farm enterprises with high labor requirements, in spite of the fact that products could be moved the long distance to outside markets at a somewhat reduced cost.

A possible exception to this may be the present reindeer industry. However, a sizable and continued demand for this type of meat would have to be developed outside Alaska, and a high enough price would have to be realized to induce commercial and native producers in the rather distant areas of Kodiak, Nome, and Kotzebue to bring forth the necessary volume.

A regional or world market for the basic products of Alaskan agriculture does not exist in this time of agricultural surpluses, produced at a much lower cost than anything the Alaskan farmer can offer. Realizing this, Alaskan farmers will avoid any overproduction beyond the needs of the local market, for in this case their price advantage (stemming from the fact that competing food products must be shipped in) would be lost. If overproduction occurred, the price level for a given product in Alaska would tend to move rapidly downward toward a basis of average U. S. prices minus shipping and handling costs from Alaska to the continental U. S. At this price level, and with their own high cost of production, Alaskan farmers could not be expected to survive.

On the other hand, inshipments of agricultural supplies to Alaska are expected to increase in the future. The present and potential volume of agricultural production will not permit establishment of major supporting industries, such as fertilizer, feed concentrate, and machinery-manufacturing plants. These supplies will always have to be imported. Their present volume of about 15,000 tons per year may increase to 50,000 tons per year, once cropland is extended to 40,000 acres and operations are intensified.

Fifty per cent self-sufficiency in the production of food, as mentioned earlier, is the maximum obtainable, but a lower goal would probably be more realistic. In spite of the fact that approximately half of the items included in a normal diet can be grown in Alaska, it is not likely that even a several hundred per cent increase of the population would permit establishment of all the necessary processing and storage facilities to assure a year-round supply of these items to the local population without resorting to seasonal inshipments. For this reason, about 25 per cent self-sufficiency in the production of food seems to be a more realistic goal for attainment in Alaska — a goal the attainment of which would be not only physically possible, but also economically feasible.

If one were to speculate about the possible extent of agriculture in Alaska in 1980, at an estimated population of about 400,000 at that time, he would find that cleared land would have to amount to roughly 200,000 acres. Out of these, 170,000 acres would be used for crops. To reach this level, an average of 9000 acres per year would have to be cleared between now and 1980, 3 to 4 times the present annual effort. Some 1300 full-time farms would have to be added to the present 200, at an average capital investment of $80,000 per farm. This would amount to an additional $100,000,000 investment in agriculture.

Though total agricultural production may provide 25 per cent of all food needs, and gross receipts from cash sales may reach $35,000,000 per year, contribution to individual food requirements would vary. Assuming that increases in production were concentrated more heavily in the livestock area, the following per cent of self-sufficiency might be gained by 1980.

Fluid Milk	66
Eggs and Poultry	50
Red Meat	30
Feed Grains	50

The bulk of wheat flour and canned goods would continue to be imported, mainly on account of the fact that even then economies of scale would not favor establishment of local processing industries.

These, however, are sketchy projections, reasonable only under the assumptions specified, and barring unexpected changes in public policy.

While at the present time military establishments in Alaska can be provided easily with some locally produced foodstuffs as well as imports, it is difficult to predict whether unforeseen future developments would make greater dependence upon local production of food necessary. If need arose, economic considerations would become secondary, and agricultural expansion in Alaska could be pushed forward at a much faster rate than is now economically feasible. Also, if, at some date in the future, U. S. population should have increased to a multiple of the present 180 million, Alaskan agricultural potential in terms of land and climate could make a valuable contribution to the provision of the food and fiber necessary to feed and clothe these several hundred million people. But this is not likely to occur within the next quarter century. Professionals in the field of agriculture have estimated that present technical knowledge, if applied to all of the acreage presently under cultivation, would be sufficient to provide a population of 350 million people with food. By the time this population level is reached, additional advances in production knowledge will have been made, which, together with additional accessible land in the continental U. S., would postpone the need to bring into use Alaskan resources for several more decades.

Need for and Benefits of Improved Transportation

Availability of adequate, efficient, and cheap local transportation is necessary for reaching and maintaining the maximum growth rate of agricultural production in Alaska that can be expected under existing limitations of soil, climate, and economic factors influencing costs of production and demand for the products. This, however, applies only to internal transportation, linking farms to local markets. It does not apply to the transportation system linking Alaska to the older 48 states, because such an ideal transportation system would lower the cost of competing food imports.

Internal Transportation. Farmers outside established settlements are presently limited in their operations by the inadequacy of country roads connecting their land to primary roads and highways. Improvement of these existing roads is needed.

For an expansion of agriculture, relatively short extensions of the local road system would be adequate to enable settlers to move supplies to their new homesteads and to bring their products to the market. Adequate agricultural development to meet up to 50 per cent of the needs of the growing population in the next 20 years can be met by (1) more intensive operations on presently occupied and cleared land, (2) operations on presently occupied but uncleared land, (3) operations on unoccupied, uncleared land along present roads, and (4) operations on nearby extensions of present road systems. In no case would construction of new major internal highways be justified for the express purpose of developing agriculture in distant areas, since most of the potential acreage for expansion is within or adjacent to existing settlements.

Transportation Between the Pacific States and Alaska. Transportation between the Pacific States and Alaska, specifically the cost of this transportation, is a major factor determining prices of imported foods in Alaska, and therewith the outlook for local agriculture.

In order to minimize this cost of transportation, nearly all food and agricultural supplies are shipped to Alaska by water. Further transportation within Alaska takes place mostly via the Alaska Railroad. Rates for this lowest-cost combination of carriers from Seattle to the Anchorage area range from $2.50 per cwt for feed grains and fertilizer to $7.50 per cwt for fresh meat and other products requiring special handling and equipment. Speed of transportation is only of secondary importance, except in the case of a few perishable goods.

Any improvement of existing, or addition of new, transportation facilities between the Pacific States and Alaska would affect the outlook for local agriculture only if costs of transportation were altered. However, the extent of benefits that could be derived by Alaskan agriculture from such a change is open to question. While a reduction of transport charges would lower cost of inshipment of agricultural supplies and therewith cost of production, it would also invite more severe competition from farmers in the other 48 states by lowering the cost of inshipment of competing food products. This is the basic dilemma confronting the Alaskan farmer.

In the short run, reductions in the cost of inshipments of supplies could not be expected to reduce the cost of locally produced commodities as much as the cost of imported foodstuffs would be reduced. In the long run, however, secondary savings accruing to local farmers through lowered cost of production of feeds and forages used at home, and lowered cost of living in general, may enable them to maintain or even improve their over-all competitive position in the local market.

While it is difficult to predict the long-run effects upon agriculture, there are other immediate benefits from a lowering of transport cost that would accrue to the entire Alaskan economy. The most obvious and far-reaching one would be a lowering of food cost. Lower cost of food, imported as well as locally produced, would contribute to a lowering of the entire cost of living, which in turn would help to draw new industries to the area.

Beneficial effects in the form of lower cost of food would accrue not only to the civilian sector of the economy, but also to the military and dependents of military personnel, now that commissary prices in Alaska must include the cost of transportation incurred.

Assurance of a more adequate food supply to the military during times of emergency, when shipment by water may be interrupted, has not been of major concern to military officials for the last few years. Yet, it cannot be denied that opening of an additional land route to Alaska would help to dissipate concern about the availability of food supplies for civilian use during interruptions of ocean shipping.

Concluding from the above observations, an improvement of existing, or opening of new, transport facilities between the Pacific States and Alaska, resulting in lower transport charges, could not be counted upon to increase agricultural expansion in Alaska beyond its present rate, in fact, it may have an adverse effect upon it. But it would benefit the economy in general by contributing to a decrease in the cost of food in Alaska, with all the secondary effects that can be expected from a lowering of the present cost of living.

Northwestern Canada

Farm production in northwestern Canada (those regions included in this study) accounts for less than 2 per cent of total agricultural output of all Canada. However, in terms of dollars it does represent a sizable sum. Gross income from the sale of agricultural products grown in northwestern Canada is estimated at $40 million per year. Including products used on the farm, value of agricultural production exceeds $45 million.

Past and Present Production

Commercial agricultural production in those parts of northwestern Canada included in this study is limited largely to northern British Columbia and northwestern Alberta. For the purposes of this discussion, these two regions have been defined as Agricultural Reporting Regions No. 9 and No. 10 in northern British Columbia (also commonly referred to as central British Columbia and Peace River, British Columbia, respectively) and the Peace River area of northwestern Alberta. Data pertaining to the areas in British Columbia are those published by the British Columbia Department of Agriculture for Regions No. 9 and 10. Statistics on agriculture in the Peace River area of northwestern Alberta were furnished directly by the Department of Agriculture, Province of Alberta.

The growing of food in Yukon Territory is confined to some 20 farms occupying approximately 4000 acres, of which less than 1000 acres are improved land. No information is available indicating any agricultural production of commercial scale in the fringe of the Northwest Territories included in this study. On the basis of this information, given by the Commissioners of Yukon Territory and Northwest Territories, agriculture in these areas was omitted from this report as being of no consequence in the provision of food to the general populace.

The extent of agricultural activity in northern British Columbia and northwestern Alberta is indicated in Table V-45. Average output of these areas during the past 25 years has increased considerably, due to increases in farm size and fuller mechanization of operations. In spite of this, variability of yields due to recurrent drought years, early killing frosts, and other adverse climatic influences make estimates of output in the short run an uncertain affair.

Agricultural production in northern British Columbia is confined to a number of small regions along the Canadian National Railroad from Prince George to Prince Rupert, and two larger areas around Fort St. John and Dawson Creek, as shown in Figure V-32. These latter regions directly adjoin the large agricultural area of the Peace River in northwestern Alberta. In addition, there are two isolated agricultural areas located farther north in Alberta.

Farms in the regions between Prince George and Prince Rupert specialize in livestock production, but do not make any significant contribution to British Columbia's total production of these commodities. Emphasis of farming in the Fort St. John and Dawson Creek areas is on grain and forage seed production. The contribution of these two regions to total British Columbia agricultural output is significant in that it amounts to 70 per cent of all grain and over 50 per cent of all forage seeds grown in the province. Yet, measured in dollars, agriculture in northern British Columbia accounts for less than 10 per cent of agricultural output of the entire province.

In the Peace River area of northwestern Alberta, cash grain and general farming predominates. Physical output, especially in the case of grains, is much greater than that of the areas in British Columbia. However, measured against the value of agricultural production of Alberta as a whole, it also amounts to less than 10 per cent of the total produced in Alberta.

Total value of agricultural production by area, and physical quantities of grains and livestocks produced, are shown in Tables V-46 and V-47.

TABLE V-45. NUMBER OF FARMS, CROPLAND, LIVESTOCK ON FARMS, AND VALUE OF AGRICULTURAL PRODUCTION, NORTHERN BRITISH COLUMBIA, AND NORTHWESTERN ALBERTA, ESTIMATED AVERAGES FOR 1956-1958[a]

	Northern British Columbia[b]	Northwestern Alberta[b]	Total
Number of Farms	2,500	9,500	12,000
Land in Farms, acres	500,000	4,000,000	4,500,000
Cropland, acres	250,000	1,750,000	2,000,000
Wheat	70,000	430,000	500,000
Barley	20,000	150,000	170,000
Oats	50,000	350,000	400,000
Rye	1,000	24,000	25,000
Flaxseed	7,000	33,000	40,000
Potatoes	500	500	1,000
Hay and Forages	n. a.	n. a.	250,000
Summer Fallow	n. a.	n. a.	500,000
Improved Pasture	n. a.	n. a.	114,000
Number of Animals			
Horses	5,000	15,000	20,000
Cattle	20,000	70,000	90,000
Sheep	1,000	10,000	11,000
Hogs	15,000	65,000	80,000
Poultry	50,000	550,000	600,000
Value of Commercial Production, dollars	8,000,000	32,000,000	40,000,000

(a) Source: "Statistics of Agriculture - Peace River Area", letter from Department of Agriculture, Province of Alberta, Edmonton, Alberta, Canada, dated March 3, 1960.
"Inventory of Agriculture in British Columbia", Extension Service, British Columbia Department of Agriculture, Victoria, B.C., Canada, as prepared for 9th B.C. Natural Resource Conference, pp 12, 13, 18.
"Atlas of Canada", Department of Mines and Technical Surveys, Geographical Branch, Ottawa, Canada (1957), Plates 64-69.

(b) n.a. = not available.

TABLE V-46. TOTAL VALUE OF COMMERCIAL AGRICULTURAL PRODUCTION, BY AREA, IN NORTHWESTERN CANADA, AND COMPARISONS TO PROVINCIAL TOTALS, ESTIMATED VALUES, 1956[a]

Area	Estimated Values, thousands of dollars		
	Field Crops	Livestock Products	Total
Northern British Columbia	3,488	4,247	7,735
Total British Columbia	32,500	74,500	107,000
Northern British Columbia as per cent of Province	10.7	5.7	7.2
Northwestern Alberta	26,173	6,385	32,558
Total Alberta	330,000	140,000	470,000
Northwestern Alberta as per cent of Province	7.9	4.6	6.9
TOTALS:			
Northwestern Canada	29,661	10,632	40,293
Total Canada	1,040,000	1,560,000	2,600,000
Northwestern Canada as per cent of total Canada	2.8	0.7	1.5

(a) Source: "Statistics of Agriculture, Peace River Area", letter from Department of Agriculture, Province of Alberta, Edmonton, Alberta, Canada, dated March 3, 1960.
"Inventory of Agriculture in British Columbia", Extension Service, British Columbia Department of Agriculture, Victoria, B.C., Canada, as prepared for 9th British Columbia Natural Resource Conference, p 18.
Drummond, W. M., and Mackenzie, W., "Progress and Prospects of Canadian Agriculture", report prepared for the Royal Commission on Canada's Economic Prospects (January, 1957).

TABLE V-47. ESTIMATED VOLUME OF MAJOR AGRICULTURAL COMMODITIES SOLD, NORTHERN BRITISH COLUMBIA, AND NORTHWESTERN ALBERTA, 1956[a]

Commodity	Northern British Columbia[b]	Northwestern Alberta	Total[b]
Wheat, 1000 bu	4,500[c]	7,588	10,000
Oats, 1000 bu	--	15,737	17,000
Barley, 1000 bu	--	12,211	14,000
Beef, number	5,000	20,000	25,000
Hogs, number	10,000	100,000	110,000
Sheep, number	3,000	50,000	53,000

(a) Source: "Statistics of Agriculture, Peace River Area", letter from Department of Agriculture, Province of Alberta, Edmonton, Alberta, Canada, dated March 3, 1960.
"Agricultural Statistics Report", Year 1955, Department of Agriculture, Province of British Columbia, Victoria, B.C. (1957), p 13.
(b) Estimates.
(c) Including oats and barley.

Resources

Physical limits to an expansion of agricultural production in Northwestern Canada, set by the primary factors of land and climate, have not yet been reached, and, judging by present trends, are not likely to be reached within the next quarter century.

Land. Of the four major soil zones found in the Prairie Provinces and British Columbia, only the grey-wooded zone, reported to be the least productive one, extends into the area under consideration. Soils of the grey-wooded zone in central British Columbia are badly leached, highly acid, have poor physical properties, and are of low natural fertility. Soils in the Peace River area are of the same type, with some areas of better soils interspersed.

In spite of the fact that fertility of the grey-wooded soils is not very high, this soil zone is considered to include the largest potential acreage for future expansion of agricultural production. Estimates of potential agricultural land acreage are:(2,3,4)

Peace River Area, Alberta	5,000,000
Peace River Area, British Columbia	2,000,000
Central British Columbia	1,000,000
Yukon Territory	300,000
Northwest Territories	None
Total	8,300,000

It is generally recognized that economic factors, such as the higher cost of developing new farmland as compared to increasing production by intensification of present operations, will prevent rapid expansion of agricultural production into these new areas.

Forecasts for the next 25 years indicate that only a small fraction of this total potential acreage will come into cultivation during this period.

Climate and Types of Farming. Climate, soil, and economic factors have dictated specialization of production in various areas. As a result, farmers in central British Columbia have concentrated on forage and feed-grain production, which serves mainly to support their livestock enterprises, such as beef, poultry, and some dairy farming. In the Peace River area of British Columbia and northwestern Alberta, grain production predominates, but a change in emphasis on crops is presently taking place. While wheat yields in that area are as good as or better than those in the more fertile soils farther south, quality of the crop is known to be inferior. As a result, most of the acreage added in recent years has been put into barley and oats; and wheat, once the predominant crop, is rapidly declining in importance as a source of income.

Mechanization of operations in the production of grains has somewhat reduced the danger of great losses during years with adverse weather conditions. However, recurrent droughts still affect grain yields considerably. Fluctuations up to 40 per cent from one year to the next are not uncommon.

Farming in Yukon Territory is carried on mainly on a subsistence level, and does not result in any quantities of food of commercial consequence.

Marketing, Processing Facilities, and Sources of Supplies

Individual production centers in central British Columbia are small. Yet they are able to support individually local services, such as local dairy plants, slaughtering houses, and feed mills. However, agriculture in central British Columbia in the aggregate is not large enough to justify establishment of any major food-processing or farm-supply industries. Most of the production goes to satisfy local needs, and little is shipped to other areas.

The Peace River area of British Columbia and Alberta, linked more directly to the farm belt of the Prairie Provinces, also has its own set of smaller local service and processing industries. Major processing industries, such as milling plants and meat-packing houses, are located closer to the center of agricultural production of the Prairie Provinces. For supplies such as fertilizer and machinery, the Peace River area, too, is dependent upon sources in the more heavily settled areas of the country.

Future Prospects for Agriculture in Northwestern Canada

The potential for further development of agriculture in central British Columbia and northwestern Alberta is considerable. But development of new farms is so expensive that the major emphasis of this agricultural development will rest on the less costly methods of (1) improving farm practices and (2) using more intensively land already occupied but still unimproved, before new land is cleared and settled.

Climate and soil considerations will make it necessary to stay with the time-proven basic enterprises of grain-crop and livestock raising. But use of more fertilizer could increase grain yields greatly, provided the necessary moisture were available. Since this is not always the case in northwestern Canada, intensification of farm operations in that area must rely more heavily upon increased mechanization, chemical weed control, and economies originating from consolidation of acreages. Extensive use of irrigation is not expected to become profitable, since it would involve capital investments not warranted by the price for and fertility of land in the area.

Costs of production of crops and livestock in northwestern Canada are not significantly higher than elsewhere in Canada in the fringe areas of agriculture. Consequently, farmers there are able to compete on nearly equal terms with farmers in other areas of the country. Certainly, their ability to make the area completely self-sufficient in the production of food is somewhat limited. Our modern diet has come to include many specialty items which will always have to be imported from areas to the south where they can be grown much more economically.

Increased production of staple foods in northwestern Canada however is a goal that is not only physically possible, but one that is also economically feasible. A ready domestic demand for additional farm products exists. Expanding requirements for meat are likely to call for a level of meat production by 1980 over twice that of the average of the past few years. Most of this increase in production is expected to come from the Prairie Provinces. The output of feed grains, extensively grown in the Peace River area, will have to rise substantially if the meat required is to be produced. Demand for wheat, based mainly on export opportunities, will continue at a level sufficient to maintain an acreage in the crop near the level considered normal during the last decade. With feed grains, wheat, and meat being the main products of agriculture in northwestern Canada, any contemplated increase in production can be expected to find a ready market.

Rate of expansion of agricultural production during the next 20 years will probably be rapid, amounting to a doubling of production by the end of this period. But, as has already been noted, most of the planned increase in production can be brought forth by intensification of operations on land already occupied, some of which is not even cleared yet, plus the potential from unoccupied land along present roads. Therefore, no significant northward movement of the boundaries of agriculture is expected to take place.

If one were to translate the above statements into figures relating to the status of agriculture in the part of northwestern Canada under consideration in 1980, he would find that land in farms may not have increased to any more than 5 million acres, only 500,000 acres above the 1956-1958 figure reported in Table V-45. The number of farms would not have changed much at all. The continuing trend toward farm enlargement and consolidation would have caused almost all of the additional areage to go into existing farms. These existing farms, however, might increase their acres used for cropping from the present 2 million to a figure closer to 3 million.

Based on predictions relative to future demand for farm products, wheat acreage will not increase significantly. Additional acreage will be used almost exclusively for the raising of more feed grains for shipment to other areas and for increased livestock operations within the area. Total value of commercial agricultural production, under these assumptions, and measured in 1960 dollars, may reach, but will probably not exceed $60 million by 1980.

Need for and Benefits of Improved Transportation

Agriculture in northwestern Canada outside established settlements is suffering from the same lack of adequate secondary and country roads that can be found in any fringe area of agriculture. Improvement of the local road system would enable farmers to transport supplies to, and products from, their farms more easily and quickly. But extension of roads into new areas of potential agricultural land for the sole purpose of increasing agricultural potential does not seem warranted as long as a substantial increase of agricultural output in accessible areas is possible.

Transportation to outside markets is presently available to all of the larger centers of agricultural production in northwestern Canada. Central and northern B. C. are served by branches of the Canadian National Railway traversing the area from Prince George to Prince Rupert, and the Pacific Great Eastern Railway, connecting Fort St. John, Dawson Creek, and Prince George with central markets in southern B. C.

Farmers in the Peace River Valley of northwestern Alberta have the Northern Alberta Railroad available for shipments to Edmonton in central Alberta. One of the two branches of track which are owned jointly by the Canadian Pacific and Canadian National Railways, but operated by the Northern Alberta Railroad, extends as far west as Dawson Creek, British Columbia, providing a link to the agricultural centers in northern British Columbia. Only the Keg River and Fort Vermillion settlements in northern Alberta do not have present access to a railroad, a situation which would be alleviated if the proposed Pine Point Railroad were built along the western route.

Railroad service is important to farmers shipping their products to the more heavily populated areas, but the railroads could not exist on freight tonnages provided by agriculture alone. Industrial and mineral opportunities (producing over 90 per cent of present tonnage hauled), and not agriculture, will determine time of construction and location of new railroad facilities.

Agricultural expansion in northwestern Canada is not presently being hampered by insufficient transportation facilities, nor could it be speeded up significantly beyond its present rate by extension of transportation facilities into new lands.

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WATER

An examination of the water resources of this huge area, with its great river systems, its countless lakes and vast glaciers, seems to be almost unnecessary. Actually, when specific localities are considered, the local water supply may or may not be adequate to meet present demands. Whether or not future supplies will be adequate is now a matter of concern. For example, the situation in Alaska has prompted the introduction of a bill in Congress to provide for "an integrated and cooperative investigation study and survey in the conservation, utilization, and development of the land and water resources of the various rivers, ports, and drainage basins" in Alaska.(1)

Available Government reports on the water resources of the Area are usually directed to the hydroelectric potential of some of the major rivers, the development of river transport, the physical character of local water supplies, the recreational opportunities of fishing streams, or the conservation of salmon spawning grounds. Hydroelectric resources are discussed earlier in this chapter. This section is concerned only with water as an industrial raw material, and with potable water resources for domestic use.

Sources of Water for Domestic and Industrial Use

In Northwest North America, water for municipal systems and for the limited number of industrial installations is obtained in much the same way as elsewhere on the continent. Certain regional factors, however, resulting from unusual climatic or geologic conditions, have required special modifications of standard water-supply practice.

The principal sources for water are:

(1) Streams and rivers

(2) Lakes and ponds

(3) Ground water

(4) Miscellaneous – rain water, melted ice or snow, springs.

Streams and Rivers

River water can provide an adequate water supply if demands do not exceed minimum stream flow. Since the sizes of the cities, towns, and villages in the area under study are small compared to the densely settled portions of North America, total water demand has not yet reached major proportions.

In the glaciated areas along the southeastern and southern coast, streams which are fed by melting glaciers are often heavily loaded with silt and "rock flour". This sediment may create a major problem for municipal or industrial water systems.

"The suspended sediment concentration of the Gulkana River at Gulkana ranged from 1 part per million (p.p.m.) on January 8, 1954, to 9,460 p.p.m. on August 3, 1954. This amounted to sediment discharged in tons per day of from less than 0.5 ton to 198,000 tons."(2)

While not all of the rivers in the mountainous coastal regions are burdened by silt the year around, this is certainly true during the high-water season for the Stikine, Taku, Chilkat, Copper, Susitna, Matanuska, and other similar rivers draining glacial areas.

Another problem of river water supply is domestic pollution by habitations upstream, and industrial pollution. This problem is intensified in areas where the rivers are frozen over for several months each year. Garbage, raw sewage, and other debris often accumulate on the surface of the ice until spring breakup occurs.

None of these problems are insurmountable, but as the population of the Area increases, a program of strict water-resource surveillance will be required, where no such programs exist today.

Lakes and Ponds

Abundant fresh-water lakes are found widely distributed throughout the Area. These lakes can be, and in some cases already are, the source of domestic and industrial water.

The city of Ketchikan uses a lake-water source. Ketchikan Lakes, Hoadley Creek, and Carlanna Lake are the three principal sources for the Ketchikan municipal water supply. This supply may be described as "an untreated surface water supply, created by rainfall and run-off from melting snow on the slopes of mountains lying within a radius of five miles of the city".(3)

Some idea of the variety in the use of lakes as water sources can be gained by comparing the Ketchikan system to Amos Alter's description of Arctic practice. "Numerous small lakes and ponds exist throughout the tundra portions of the permafrost regions. The Eskimo depends largely on water dipped from these sources during the warmest months of the year. In the fall he cuts ice from these sources and stores it for his use during the long winter. Ice is either stored in a permafrost cellar or stacked on the ground at a convenient location."(4)

Principal advantages of lake water are freedom from silt, and in the case of the larger lakes, continuous supply during the winter months, even if frozen over. The number of lakes whose water is today unused by man is so great as to postpone any lake water shortage into the distant future.

Ground Water

Ground water is of only minor interest for water-supply purposes along the rugged coastline of Southeastern Alaska, but is of major importance in the interior. Since it is in the interior that the extreme low temperatures in winter are the rule, here the prevalence of prolonged low temperatures has produced permafrost conditions. Frozen ground is impervious to the movement of ground water, hence the surface of the permafrost zone, in summer, forms a water table about 6 to 10 feet below the surface. Shallow wells to such temporary water tables are satisfactory for one-family use, subject to the usual hazards of contamination. Wells have been drilled to tap ground water supplies beneath the permafrost zone, where the base of this zone is comparatively shallow. In such cases, prevention of the water freezing as it passes through the frozen layer is an added item of expense.

"The Tanana Valley, in which Fairbanks is located, with its gravelly fill was found to be one of the most prolific sources of ground water in the world."(5)

In the area of Cook Inlet, the climate is mild enough to permit "normal" accumulations of ground water. "Municipal supplies from wells have been developed at Valley, Moose Pass, Homer, Kenai, and Anchorage. More than 300 wells have been developed in the Matanuska Valley agricultural area".(2)

Occasionally local geologic conditions have produced unfavorable ground-water composition. High iron content, resulting in a pronounced "taste", is a common complaint. "The southeastern part of the Copper River Basin is a specific area of poor quality ground water. The areal extent of this hard and highly saline water has not been fully defined, but poor quality water occurs in the general area bordered by Gulkana on the north, Copper Center on the south, and extending at least 15 to 20 miles to the east and west of the Copper River."(2) This situation is not necessarily a handicap to local development, since surface-water supplies can usually meet foreseeable needs.

At Kotzebue, a well drilled below the permafrost zone encountered salt water.(6)

Miscellaneous Water Sources

Rain water is still caught in many areas, especially where soft water for home laundry use is desired.

In the Arctic area, the melting of ice or snow is a common practice in the winter time. Such a method has its obvious economic limitations, especially where fuel is scarce.

Numerous springs have been reported in the literature, although few are of sufficient size to constitute a major water supply. "The largest spring in the Anchorage area is the Russian Jack Springs in the lowland west of the Prison Farm. The flow from this spring is estimated at about 2.8 million gallons per day and has a constant temperature of from 37° to 38°F."(7,8)

Industrial Water Uses

The two major industrial consumers of water in the area under study are the pulp mills at Sitka and Ketchikan. Mining operations at Cassiar in British Columbia, at Keno Hill in Yukon Territory, and placer gold mining near Fairbanks and Nome can be classed as industrial users of water.

The salmon and crab canneries along the coasts require water for product cleaning and preparation for steam generation, and for sanitary and housekeeping purposes.

Oil-well drilling requires modest amounts of water for drilling mud "make-up", maintenance of equipment, and engine cooling. The exploration programs now underway on the Kenai Peninsula and elsewhere have encountered no serious water-supply problems.

Steam-electric generating plants are located at military and municipal installations in and near Fairbanks, at Fort Richardson near Anchorage, at the two pulp mills mentioned above, and elsewhere. Water for condenser use is readily available at all of these locations.

Domestic Water Use

The major population centers of Northwest North America require insignificant amounts of water in comparison with the huge quantities available. In Alaska, the four major cities of Ketchikan, Juneau, Anchorage, and Fairbanks together consume 13.3 million gallons per day.[2] Large increase in population could occur before any shortages of domestic water supplies develop in this area.

Summary

There is no shortage of water in Northwest North America at the present time. Local demands sometimes exceed the supply, but these rare occasions are the result of inadequate collection and distribution, rather than lack of adequate resources. Special climatic conditions now affect, and will most surely influence, the development of water supplies for future requirements. Additional ground-water data are needed in most areas where this is the principal source of supply, and no intelligent assessment of total reserves can be made until the needed data are available. With proper planning, with careful engineering design to avoid costly freeze ups, and with enforced sanitary practices, future communities can look forward to adequate supplies of domestic and industrial water.

Abundant water supplies will help to attract those industries which normally require large quantities of water. However, other factors, such as availability of raw materials, distance to markets, and labor supply, are often more critical in industrial site selection than is the water supply.

References

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TOURISM

Tourism ranks as one of the most important present and potential economic activities of Northwest North America. Alaskan travel activity, heavily concentrated in the five months from May through September, involves almost as many people as live in Alaska on a permanent year-around basis, excluding the military. This activity focuses on the major cities of Juneau, Anchorage, and Fairbanks in Alaska, and on Whitehorse, Dawson, and Dawson Creek in Yukon Territory and British Columbia. The contribution of tourism to the economy is not presently measured by any official statistical group and is therefore subject to estimate only.

In 1955 the National Park Service ranked tourist recreation ". . . third or fourth among the sources of new production dollars" in Alaska. Tourism as a "basic" economic activity, brings in outside or "new" money to the local economies thereby providing a boost for construction, manufacturing, agriculture, transportation, and the service industries. It also seems desirable to define tourism, and tourists, in order that the following discussion may be more clearly understood.

Tourism is meant to include the whole complex of what tourists do plus the activities of those who serve tourists. But what is a tourist? A tourist, according to Webster's New Collegiate Dictionary, is "one who travels from place to place for pleasure or culture". However, this definition may be too narrow. Today, the people in the travel business apply the term "tourist" to anyone who travels away from home. * There are several additional reasons for considering all travelers rather than just those who are traveling for pleasure. First, it is believed that most business travelers to the study area do combine some pleasure with their visit to Alaska and northwestern Canada due to the newness and uniqueness of the area as well as its unparalleled natural attractions and its distance from the major population centers. Finally, the available statistics count travelers, with no distinction being made between vacation and business travel motives. A clear distinction between the terms "tourism" and "the travel business" is not possible. Even though an attempt is made to be as specific as possible, it will some times be necessary to use terms such as: traveler, tourist, visitor, and passenger somewhat interchangeably in this analysis.

Analysis of Alaskan Travel

Alaskan travel has increased importantly in the period 1955 through 1959, displaying both a highly seasonal character and the growing importance of automobile traffic to and from Alaska. Beginning in May, the excess of northbound passengers from the states causes the population to increase rapidly from the winter low to a summer high in late July or early August. During August the volume movements abruptly change direction and the departures by air, water, and land rapidly deplete the summer buildup.

* The Tourist Business, Office of Area Development, U. S. Department of Commerce, U. S. Government Printing Office, Washington, D.C. (1957), p iii. This definition agrees with that provided by the National Association of Travel Organizations in its 1959 Annual Report: ". . . the travel business is the art of attracting, entertaining and servicing visitors. A visitor is the man who is far enough away from home to need the food, lodging, entertainment, and services which people in the travel business have to offer".

Whereas this cycle has been repeated yearly without significant interruption, the amplitude of the "in" and "out" flow of people has increased rather steadily since 1955 except for the recession year, 1958. General reports indicate that 1960 will see fewer passengers than 1959, but more than 1958.

The greatest problem in making a realistic analysis of travel in Northwest North America is the inadequacy, vagueness, and general lack of reliable statistical information pertinent to the study area. The data presented in Table V-48 on Alaskan passenger movements from 1955 through 1959 illustrate this problem.

In the first place, the passenger movements include tourists, migratory workers, business travelers, military persons, Alaskan residents – in fact, all known in-and-out travelers undifferentiated as to whether they are on business, a pleasure trip, both, or have some other purpose in traveling. The available statistics do not permit a definitive separation of passengers by travel motive. *

Second, some double-counting of auto passengers may occur because persons traveling between Southeastern Alaska and the rest of Alaska on the Haines Highway must pass through Canada. It is not known how many persons are counted twice for this reason, but the total is believed to be small because certain sources state that the statistics reported have excluded "local traffic". [1a]

Third, passenger movements on the White Pass and Yukon Railway are not included in this table even though rail service is available year-round and 10,790 persons used this transportation route from May to September 18 in 1959.

Fourth, this table also does not include any count of the numbers of persons who may move across the Alaskan border by any of a number of smaller individual types of transportation media. For instance, there have been private flying groups (and individuals) visit Alaska from the states (60 planes from Miami – Flying Farmers, etc.). Pleasure yacht groups and boating individuals visiting Alaska do not appear in the figures, nor do the movements of persons in special government and military planes, boats, and field parties. Movements of military persons by MATS and MSTS are included in the figures and this is the first time such movements have been published.

Fifth, these figures do not include any count of noncommercial passengers such as might visit Alaska as crew of a water carrier hauling cargo to or from Alaska, or any other kind of non-Alaskan fishing, naval, or other type of vessel.

* The Alaska Resource Development Board in its most recent issue of: "Estimate of Alaska Population", July 1, 1956, to June 30, 1957, Report No. 6 – in Cooperation with Bureau of Vital Statistics, Alaska Department of Health, says on page 3 that this enumeration provides ". . . a reasonably accurate check on the number of people emigrating from and immigrating to Alaska (emigrants and immigrants refer to such itinerants as seasonal construction workers, fishermen, cannery workers, miners, salesmen, and tourists, as well as bona fide residents, because there is no way to distinguish one group from the other)".

TABLE V-48. ALASKA PASSENGER MOVEMENTS BY TYPE OF TRANSPORTATION USED, 1955-1959[a]

Type of Transportation	Number of Passengers														
	1955[b]			1956[b]			1957			1958			1959		
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
Airlines Total	89,722	103,891	193,613	100,813	114,451	215,264	103,622	113,364	216,986	102,476	108,700	211,176	113,677	119,171	232,848
Commercial	73,854	84,748	158,602	82,013	93,777	175,790	86,933	96,320	183,253	84,821	90,112	174,933	94,437	99,312	193,749
MATS[c]	15,868	19,143	35,011	18,800	20,674	39,474	16,689	17,044	33,733	17,655	18,588	36,243	19,240	19,859	39,099
Automobile Total	39,506	35,437	74,943	49,798	46,254	96,052	53,430	53,099	106,529	47,795	46,569	94,364	63,527	58,224	121,751
Alaska Highway	n.a.	n.a.	57,977	n.a.	n.a.	76,715	44,342	44,805	89,147	35,164	34,152	69,316	45,828	40,993	86,821
Haines Highway	n.a.	n.a.	16,946	n.a.	n.a.	19,377	9,088	8,294	17,382	12,631	12,417	25,048	17,699	17,231	34,930
Steamship Total	11,136	9,909	21,045	11,789	10,140	21,929	12,708	12,208	24,916	11,353	11,602	22,955	17,924	16,567	34,491
Commercial	5,975	6,100	12,075	5,752	5,125	10,877	8,410	8,315	16,725	7,705	7,767	15,472	12,099	12,387	24,486
MSTS[c]	5,161	3,809	8,970	6,037	5,015	11,052	4,298	3,893	8,191	3,648	3,835	7,483	5,825	4,180	10,005
Total All Types	140,364	149,237	289,601	162,400	170,845	333,245	169,760	178,671	348,431	161,624	166,871	328,495	195,128	193,962	389,090

(a) Source: Compiled from data supplied by: Alaska Resources Development Board, Division of Tourist and Economic Development, Alaska Department of Commerce, and Statistical Services Center, U. S. Department of Defense.

(b) n.a. = not available.

(c) The figures in this category include all passengers known to have used the military carrier itself or a carrier under contract to MATS or MSTS.

Sixth, a reliable source says that the automobile passenger figures do not include truck drivers.(1b) In 1959, the Alaska Highway count was 3,700 trucks and there were some 3,800 truck movements on the Haines Highway. Seventh, the air-passenger figures do not count the crews of the numerous air carriers both scheduled and nonscheduled commercial and government (including military) that cross the Alaskan border. Eighth, also not included are passengers on "through" international flights who deplane temporarily at Anchorage (or Fairbanks) for any of a number of reasons (weather, change flights, etc.). Ninth, even though the private plane is almost the "auto" of the north, the figures in Table V-48 do not take any cognizance of the passengers of Canadian or Alaskan private, individual, and company planes crossing the border.

Finally, it must be recognized that this analysis concerns itself only with passengers traveling into and out of Alaska. Of course many tourist dollars are spent in Alaska by persons who never cross the state boundary. While this intra-Alaska tourism activity is important to the Alaskan economy, the relationship between this activity and the need for improved or additional transportation between Alaska and the other States is indirect and has not been studied since it is outside the scope of this analysis.

All in all there are many gaps in the data, and the total figures are far from complete. The following factors tend to offset this incompleteness.

(1) There may be as many as 20 per cent of the travelers counted in Table V-48 that are Alaskans. They could not be considered to be full-time (17-day stay) tourists in Alaska because they are probably going "outside". On the other hand they may contribute almost as much to the Alaskan economy because their air ticket is bought in Alaska* whereas the calculated average expenditures of the Alaska-bound air tourist from the states do not include the cost of air transportation from home to Alaska and return.

(2) Some unknown proportion, perhaps 5 per cent of the total annual number of travelers, represents seasonal Alaskan employees who may spend less money per day than the average tourist expenditure but they stay longer in Alaska and may spend a total sum greater than the tourist.

(3) Passenger round trips made on military carriers, MSTS and MATS, or carriers under contract to the military are included in the figures (some 25,000 in 1959). The extent to which these persons contribute to Alaskan tourism is undoubtedly less than the tourist on a package tour.

This discussion of the limitations of the basic data could be greatly enlarged to cover other significant facts bearing upon Alaskan tourism. However, an examination of the various possible impact relationships of these data suggests that the most meaningful approach is to consider that the understatements and the overstatements approximately balance out and proceed with the analysis based upon the data as presented in Table V-48.

* When Alaskans travel "outside", they usually go by air, sometimes by car, but very seldom by water.

Summarized data on passenger movements in Table V-48 have been recalculated to show percentage changes and percentage increases in Tables V-49 and V-50. During the 5 years from 1955 through 1959, Alaska passenger traffic experienced a net increase of 34.3 per cent (Table V-49). Except for 1958, each year the total number of passenger movements exceeded the previous year's figure. However, the experience of the individual carriers varied significantly. For instance, while the airlines were increasing their absolute number of passengers carried (Table V-48) and thereby experiencing an increase of 20 per cent in their business (Table V-49), they were at the same time losing ground relatively (almost 2 per cent per year), decreasing from a position where they carried 67 per cent of the total passengers in 1955 to their 60 per cent position in 1959 (Table V-50). The steamship traffic increased 64 per cent from 1955-1959 due to an additional steamer being added during Alaska's highest tourist year to date.

For a considerable number of years prior to World War II the Alaska Steamship Company provided an essential regular passenger service to coastal Alaska. This passenger service was discontinued in the fall of 1954, leaving most of the passenger movements to the airlines. Steamer passenger numbers decreased substantially in 1955 due to this discontinuance of all-year service. Since then, summer passenger service has been provided, to the communities of Southeastern Alaska only, by three Canadian-chartered steamship lines (Canadian Pacific and Canadian National Steamship Companies plus Alaska Cruise Lines, Inc.). By 1956, supplementary summer cruise ships were in operation and the passenger volume increased. As of mid-1960, there was no regularly scheduled steamer passenger service to any Alaskan port outside of Southeastern Alaska, nor were there any known plans to inaugurate such service.

One of the important developments to note is the steadily increasing absolute and relative share of the passengers accounted for by automobile travel (Tables V-48, -49, and -50). The highways have increased their share of the passengers substantially, moving from a position of carrying one-fourth of the passengers to a position where they carry nearly one-third of the passengers (Table V-50). There has been no significant increase in the number of persons carried per car, the figure of three having held fairly steady for some time.

Regardless of their place of residence, the travelers develop a substantial seasonal demand for services. This highly fluctuating demand and the high traveler/resident ratio are two of the major aspects of Alaskan tourism and bear importantly both on the size of the business today and on its growth potentials. Other significant and related factors include: (1) the quality, quantity, and variety of tourism resources available to the travelers, (2) the cost of these tourist objectives, and (3) their accessibility in terms of time, comfort, safety, and distance as contrasted with competitive alternative tourism objectives.

The Nature of the Alaskan Visitor

From numerous interviews with travel agents and executives of transportation lines serving Alaska it is apparent that the Alaskan visitor is quite different from the typical U. S. tourist. What is the Alaskan visitor like?

TABLE V-49. PERCENTAGE INCREASES IN ALASKA PASSENGER MOVEMENTS, 1955-1959

Type of Transportation	Percentage Increase in Passenger Movements 1955-1956	1956-1957	1957-1958	1958-1959	1955-1959
Airlines	+11.2	+0.8	-2.7	+10.3	+20.3
Automobile	+28.2	+10.9	-11.4	+29.0	+62.5
Steamship	+4.2	+13.6	-7.8	+50.2	+63.8
All Types	+15.1	+4.6	-5.7	+18.7	+34.3

TABLE V-50. CHANGES IN PROPORTION OF ALASKAN PASSENGERS USING VARIOUS TYPES OF TRANSPORTATION, 1955-1959

Type of Transportation	Percentage Composition of Annual Passenger Movement 1955			1956			1957			1958			1959		
	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total	In	Out	Total
Airlines	63.9	69.6	67.2	62.1	67.0	64.6	61.0	63.5	62.3	63.4	65.1	64.3	58.3	61.4	59.9
Automobile	28.1	23.8	25.8	30.7	27.1	28.9	31.5	29.7	30.5	29.6	27.9	28.7	32.6	30.1	31.2
Steamship	8.0	6.6	7.2	7.2	5.9	6.5	7.5	6.8	7.0	7.0	7.0	7.0	9.1	8.5	8.9
Total All Types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The Alaskan visitor today is one of four major types. The first type is the most numerous and may be characterized as follows: (1) a senior citizen probably over 60 years of age; (2) more likely female than male; (3) comes as a member of a conducted tour during the months of June, July, or August; (4) seeks quiet relaxation, comfort, and uncomplicated entertainment more regularly than strenuous pioneer or spartan experiences; and (5) can generally afford to purchase what the eye fancies.

The second type is probably somewhat less numerous but can be described as follows: (1) aged 35 to 50, (2) male, (3) comes individually or as a member of a very small group of three or four, (4) generally lives a strenuous Alaskan vacation that is often highly specialized – maybe somewhat bizarre, and (5) can generally afford to purchase what he wants.

The third type of visitor is much in the minority in Alaska but is the typical tourist in the southern 48 states and provides the major hope for a substantial development of Alaskan tourism. This person is typically as follows: (1) probably between 25 and 45 years of age; (2) more likely to be head of a household having either three or four members; (3) travels independently of travel agents, schedules, and reservations; (4) seeks both active and less strenuous tourist objectives, and (5) must frequently forego some attractions offered the tourist.

The fourth type of traveler is a man on private or government business, either exploring opportunities for new business for his company, or on a periodic sales or inspection trip. He might also be a seasonal worker.

Visitor 1 probably toured Alaska via steamer up the Inside Passage to Skagway, then over the White Pass and Yukon Railway to Whitehorse, by air-conditioned bus to Fairbanks, taking an extra flight to Point Barrow or Nome before riding the Alaska Railroad to Anchorage, and then boarding a plane for the states on the seventeenth day after departure.

Visitor 2 probably flew to a major Alaskan city as a first-class passenger or by chartered or private plane, leaving almost immediately after arrival for a week of fishing or hunting in a secluded Alaskan location followed by an equally rapid return to one of the southern 48 states, arriving about 11 days after leaving home.

Visitor 3 is from the southern 48 states. He probably stopped at the Canadian-U. S. border and every major town between there and Fairbanks or Anchorage to buy gas and oil, film, food, and notions for the family. They may be on their way to see friends or relatives in Alaska. The family must travel at a reasonably moderate pace, so the trip from home to Alaska requires 5 or 6 days. Visiting friends and tourist attractions throughout Alaska takes about 17 days in all, and they finally return home about 25 days after beginning the vacation.

Visitor 4, the businessman, may also spend an average of 17 days in Northwest North America usually flying in and out, spending freely on hotels, motels, taxicabs, and entertainment.

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The visitors described here had the following Alaskan experiences:

Visitor 1 had a first-class comfortable introduction to the Arctic frontier spread over 17 leisurely days at a cost of approximately $700 (per capita expenses of about $40 per day) about one-half of which stayed in Alaska.

Visitor 2 had a fishing or hunting trip custom-tailored to his desires and pocket-book. This trip to a little known part of Alaska cost him about $550 (per capita expenses of about $50 per day) about half of which entered Alaskan commerce.

Visitor 3 spent about $1020 (per capita expenses of about $20 per day*, using the accepted average of three persons per car), for a fairly exhausting combined driving marathon and endurance contest for the car and the family. Virtually all of his money contributed to the economic impact of tourism in Northwest North America.

Visitor 4 spent about $40 per day on lodging, food, local transportation, and entertainment for a total of $680 in 17 days. The migrant worker would have spent less per day but he usually would have stayed longer.

Obviously the automobile tourist has been penalized but at the same time his per capita contribution to Alaskan tourism coffers equaled or exceeded that of the other three tourist types.

Is there a way to improve his lot in order that more auto tourists may be attracted to visit Alaska? Would not a shorter route over a paved surface combined with a non-driving water cruise return trip sound much more inviting to prospective family car drivers when they are considering where to go next year? Is it not reasonable to postulate that improved accessibility with lower costs, easier driving, shorter driving time, a more enjoyable scenic route, and improved accommodations and facilities would significantly stimulate the volume of automobile tourists? Battelle's answer is a resounding "yes".

The Tourism Resources of Alaska

Alaskan tourism attractions and assets defy quantitative evaluation. In fact, it is more appropriate to describe than to count or evaluate the vast and varied areas that comprise the new state's recreation and travel resources.

This analysis is not an attempt at a detailed inventory and survey of specific recreational resources because such an original study is beyond the scope of this project. Battelle feels that the large amount of recent and current activity in studying Alaska's recreational resources will soon yield significant results important to Alaska's proper development of this valuable resource. The most pertinent developments are as follows:

* This $20 cost per person per day is probably an overly conservative figure. Mr. C. F. Proud, Travel Director for the Chicago Motor Club recently reported to the New York Times (7/29/60) that a vacationing couple driving about 300 miles daily should plan to spend about $40 a day. Generally speaking, Alaska Highway prices are somewhat higher.

(1) An inventory for the National Forest areas within Alaska is currently underway by the Forest Service of the U. S. Department of Agriculture as part of its Operation Outdoors with a final report to be made by April 1, 1961.

(2) A detailed comprehensive tourism survey for all of Alaska is being conducted currently by the University of Alaska under a contract with the Small Business Administration as part of its 1960 Small Business Research Grants Program.

(3) In 1953, 1954, and 1955 the National Park Service published four parts of its detailed Alaska Recreation Survey and it is currently engaged in development activities under its Mission 66 Program. *

(4) The Conservation Foundation under a contract with the Outdoor Recreation Resources Review Commission is currently studying Alaska's recreation potential for the purpose of identifying desirable policy for federal and state land programs in a report scheduled to appear about December, 1960.

(5) The firm of Arthur D. Little, Inc., under an economic development study contract with the State of Alaska, is currently investigating programs and means to develop the tourist business.

(6) Several major publications such as: Holiday, The Saturday Review, Fortune, The Alaska Sportsman, and numerous others have presented lengthy detailed articles following the award of statehood to Alaska.

(7) The Division of Lands in the Alaska Department of Natural Resources has appointed a new superintendent of Parks and Recreation who will "develop and expand present recreation facilities and provide long-range planning".

(8) The Bureau of Land Management is cooperating with the Division of Lands in a program to provide camp grounds, parking areas, and other recreational facilities in areas that the new state may select under its statehood land grant of 103,350,000 acres to be made available during the 25 years following statehood in 1959.

Major Outdoor Recreation Areas

The immenseness, variety, grandeur, uniqueness, and primeval beauty of Alaska's natural recreational areas demand at least a general regional characterization.** Surely there are many possible ways to divide the new state into recreational areas, and one

* Alaska Recreation Survey: "A Recreation Program for Alaska", Part 2, Volume 2, National Park Service, U.S. Department of the Interior, Govt. Printing Office, Washington D.C. (1955), contains a detailed inventory of desirable physical improvements.

** Immediately acknowledged is the virtual impossibility of providing here a regional treatment that would satisfy all interested parties for an area as immense (one-fifth the size of the southern 48 states) and as diverse as is Alaska. Those desiring more than this very brief treatment would probably appreciate the much more detailed and adequate description contained in Landscapes of Alaska, Howell Williams (Ed.), University of California Press, Berkeley (1958).

regionalization might be as follows: Southeastern Alaska, the Cook Inlet-Prince William Sound area, Interior Alaska, Western Coastal Alaska, and Northern Alaska. Actually, these areas merge rather imperceptibly one into the other.

Southeastern Alaska's dominant physical feature is the Inside Passage, a protected marine highway lying between the Coast Mountains and the islands of the Alexander Archipelago. The relatively mild humid Marine West Coast climate extends some 350 miles from the luxurious dense spruce-hemlock forests near Ketchikan northward past the state capital at Juneau. In addition to the capital city and the fishing ports, canneries, and lumber- and pulp-mill towns, this southeastern area offers tourists some of the remaining evidences of the Russian occupation of Alaska of a hundred years ago plus the rich Indian culture (mainly Tlingits) of generations of totem-pole makers, hunters, and fishers. This is the portion of Alaska which is nearest to the 48 states and through this region access is gained to Yukon Territory via the picturesque route of the narrow-gauge White Pass and Yukon Railway.

The Cook Inlet-Prince William Sound area is one of Alaska's most developed areas. The bustling city of Anchorage, the Matanuska Valley farming area near Palmer, and the port and railhead city of Seward attest to the quickened pace in this land of fiords, northern-type agriculture, mountainous ice and snow accumulations, paved highways, and gigantic tides (38 feet) approaching those famous 40-foot tides of the Bay of Fundy. Moose graze near the new oil wells on the Kenai Peninsula while big-game hunters and fishermen find that Alaskan experiences can indeed match Alaskan stories.

Interior Alaska is the Alaska perhaps most often depicted to the outsider. Temperature extremes are much greater here and the absence of the modifying marine influence plus the great length of day (or night, according to the season) provides the environment that brings the Arctic to mind. This is the land of the dog teams, ice-bound lakes and rivers which "go out" or break up with the spring thaw, the simple moss-chinked log cabin homes and friendly, but lonely, settlements of the frontier. Amidst the summer haze of unchecked forest fires and some miles south of the meandering loops of the mighty Yukon River lies Fairbanks as the northernmost outpost of urban life as it is known in the southern 48. The nearby huge gold dredges, dairy farms, and State University belie the fact that not too many miles away the frontier reigns supreme – harsh, defiant, and as yet unyielding with permafrost, muskeg, and tremendous quantities of untamed potential hydro power flowing silently past grazing moose and sunning grizzly.

Western Coastal Alaska is an area of vast distances punctuated only very sporadically with a small cluster of humanity. To the south the Aleuts inhabit the Pribilof (seal) Islands and the volcanic barrier chain, the Aleutian Islands, between the cold Bering Sea and the relatively much warmer Pacific Ocean. The foggy conditions caused by the interaction of the dissimilar air masses over these two water bodies nurture range conditions adequate for sizable herds of grazing animals.* Archeological evidence of the migration of early man plus the remaining traces of the slight Russian occupation of the area lend additional highlights to this remarkable island arc that extends out to the great Pacific fishing grounds where American vessels encounter Russian, Japanese, and Canadian fishermen.

* The Arctic caribou herds were estimated to number about 150,000 plus 100,000 elsewhere in Alaska in 1956 [see: Lowell Sumner and John L. Buckley, "Your Stake in Alaska's Wildlife and Wilderness", Sierra Club Bulletin (December, 1956), pp 9 and 10]. Reindeer herding involved about 250 people [see: John L. Buckley, "Wildlife in the Economy of Alaska", Biological Papers at The University of Alaska, No. 1, Revised (December, 1957), p 19].

The western coastal areas north of the Alaska Peninsula are inhabited mainly by the Eskimo. The airplane, river boat, and dog sled loosely bind the scattered settlements together. The rich historical legacy of Nome, its gold, and the Eskimo and his ivory carvings attract inquiring visitors to this little known part of Alaska.

Northern Alaska lies north of the Arctic Circle and contains the most remote and in some ways the most unique landscapes. The Alpine glaciation of the Brooks Range matches in interest the tundra and polygonal-sectioned ground surface of the lower foothills and Arctic coastal plain. These mountain crags, treeless barren-appearing slopes, and water-interlaced lowlands support a surprising variety of wildlife including: wolves, caribou, mountain sheep and goats, porcupine, fox, grizzly and black bear, wolverines, marten, otter, beaver, hare, lynx, ptarmigan and various waterfowl and fish. Caribou herds numbering 3,000 to 30,000 migrate across the area. The beach and offshore shallows are rich in whale, walrus, seal, polar bear, and wildfowl. This seemingly inhospitable land of the midnight sun supports Eskimo bands and harbors quantities of coal, oil, and gas under its surface.

Major Tourism Attractions

Alaska's major attractions today are those derived from nature's handwork rather than those made by man. The natural history tourism resources, including archeological and geological features, are vast. The migration route of ancient man to the new world from Eurasia presents unique tourism objectives which cannot be duplicated and are matched only by the opportunity to see and study live volcanoes, permafrost, and real glaciers.

The unique landscapes of Alaska provide an opportunity to see, study, and appreciate the alpine glaciation for which Switzerland is famous, wooded-fiorded coastlines not unlike those of Scandinavia, and the tundra and boreal forest landscapes of arctic lands such as Siberia. Mount McKinley, as the tallest peak in North America, affords one of the many scenic opportunities unique to Alaska.

As many another state has done, Alaska could capitalize on its rich treasury of water features (lakes, rivers, beaches, and waterfalls) not only for their scenic values but also for the recreation and sport opportunities they provide (boating, swimming, fishing, etc.). Unique tourist attractions such as the Nenana Ice Derby at Fairbanks, or the Salmon Derbies at Ketchikan and Juneau are definitely Alaskan in flavor and deserve promotion and development.

Alaskan forests attract the visitor and are of two main types – the thick set luxuriant stands of coastal softwoods and the sparse patches of diverse hardwoods of the interior. Each offers its particular brand of recreational enjoyment. Alaskan forests, in many instances, have the additional advantage of being primitive and relatively unspoiled by man. Although forest fires have significantly altered the forest in some areas, many Alaskan forest areas offer the special attributes of wilderness areas and the accompanying attractions which seemingly one must travel farther to find each year. Additionally, the person interested in trees and forest ecology generally will find a variety and broad range of trees and forest types over the variegated face of Alaska.

Unique situations such as the "drunken forest"* and the lowered tree line of polar areas are potential if not actual tourist attractions.

Hunting and fishing loom large in the future of Alaskan tourism.[2] More than adequate fishing is fairly generally available even near the major highways and towns. Hunting, including big game hunting, is an activity enjoyed by many Alaskans and visitors all over this big state.

Alaska's big game animals are numerous, varied, and quite attractive to visitors. The most important species include: the bears (brown, black, Kodiak, grizzly, and polar), moose, caribou, deer, Dall mountain sheep, Alaska mountain goat, and numerous smaller animals. Hunters find guides and transportation available, at prices up to $1,000 to $2,000 per man for a 10-14 day trip, and each year since 1954 there have been about 30,000 hunting licenses sold annually.[3] From this discussion, it is clear that Alaskan wildlife resources require and deserve conservation similar to Alaska's other resources.

Climate, wildlife, and in fact the whole arctic and subarctic ecology present tourism objectives of high and enduring quality. Numerous weather phenomena have Alaskan identities (Chinook winds) and the arctic habitat does already attract considerable interest as shown by the increasing number of tourists who visit Point Barrow (in summer, for the Eskimo culture and tundra landscapes, and in winter, for the polar bear hunt) or who boat down the Yukon River crossing the Arctic Circle twice. The year-round availability of winter sports presents additional means of tourist enjoyment related to Alaska's climatic resources.

Alaska's man-made tourist attractions include both the conventional and the unique. Its golf courses, swimming pools, picnic areas, scenic look-out points, and other conventional tourist facilities are both attractive and growing in number. These, however, are more in the nature of service facilities for the local population, and people who are drawn to Alaska by man-made attractions seek developments that have a definite Alaskan flavor.

The Eskimo, Indian, and Russian architecture, influences, artifacts, and people unfold to the visitor another new, always interesting, and sometimes bewildering side of the forty-ninth state. The stories, legends, and ways of these folk, as seen displayed on the fabric of Alaska's history, provide a different perspective of Alaska: the historical monuments and areas take on additional meaning. Certainly many would like to visit the areas that provided the backgrounds for the fascinating writings of Rex Beach, Jack London, Robert Service, and others.

There are other less serious aspects of Alaskan life of interest to the visitor and these include the rodeos, dog-team races, pageants, and the well-known fishing derby. Some of the flavor of the new state is savored by visits to the mining, fishing, or lumbering operations so characteristic of this natural resource oriented economy, though trips to these spots may be a bit difficult for the average tourist to arrange.

Another generator of tourist visits is the business trip. Undoubtedly many a curious or appreciative business traveler has lengthened his trip or returned to Alaska in order to satisfy a tourist objective.**

* The term "drunken forest" describes the appearance of trees that are no longer standing straight up due to the disturbance of the ground from the differential thaw of the subsurface permafrost.

** New business opportunities and government activities are strong incentives for the business traveler, and the migrant worker's job would hardly be called a tourist attraction except that it does bring in a visitor to Alaska.

Not to be overlooked in this brief review of tourist objectives is the old standby – visiting friends and relatives. Such information as is available points to many visits for this reason. Also the desire on the part of persons who have lived temporarily in Alaska (during wartimes or during construction periods) to return to Alaska seems to be a relatively important factor in Alaska's tourist trade.

Main Conditions Affecting Tourism

Tourism, like other business activities in a free competitive economy, prospers when the visitor recognizes that the benefits to be received in satisfying his wants bear a reasonable relationship to the costs incurred. But what are the benefits, what are the costs, and how are they to be measured in order that the attractiveness of Alaskan tourism opportunities may be evaluated and found favorable in competition with alternative want-satisfying objectives?

The primary benefit of tourism, from the tourist's viewpoint, is the satisfaction of his want for a particular experience such as: a view of Mount McKinley; hunting Alaskan wildlife with camera, gun, hook, or bow; watching Eskimo or Indian festivities; participating in an Alaskan salmon derby; studying outstanding natural history sites such as the area containing the related volcanoes – Katmai and Novarupta – and their Valley of Ten Thousand Smokes; participating in Alaska's winter sports, witnessing a dog-sled race, or visiting Alaskan Gold Rush sites and talking with Alaskan pioneers. How does the tourist assign monetary values to experiences such as these or to the spiritual, mental, and physical rejuvenation obtained from a week's stay at a remote tourist lodge or camp set amidst the majestic solitude and serene beauty of many Alaskan areas?

The impossibility of providing a practical answer to the question of how to assign monetary values to a tourist experience indicates that relative rather than absolute values are recognized by the tourist. The conclusion follows that it behooves Alaska to provide high quality tourist objectives and to effectively promote them with a continuous, dynamic, and perceptive program.

The tourist objective that clearly provides a definite experience accompanied by an agreed upon minimum amount of comfort and safety is of high quality.* An effective promotional program persuades tourists that the touted experience is preferred over others. Having defined the main conditions affecting the business, the next step is to relate them to the current Alaskan tourism situation.

The Current Situation in Alaskan Tourism

As mentioned earlier, the regrettable lack of basic quantitative Alaskan tourism information seriously limits any detailed attempt at a sophisticated over-all analysis of the current situation. The nature and potential economic significance of Alaska's tourism resources are much more difficult to describe and interpret than is true for the other states of the U. S.

* There is no connotation of morality or ethics involved in this use of the term "quality". No judgment is made here of whether studying natural history is of greater "quality" than a night clubbing experience.

Due to virtually complete federal ownership of land in Alaska, the present character of Alaskan tourism differs little from the almost virgin situation described in 1937(4) and again in 1953-55(1, 5) except for improved air service. In the past, the results of the federal government attempts to develop or promote tourism or the recreational use of federal lands in Alaska have not been outstanding. Such development as does exist is chiefly by the National Park Service (the only federal agency having recreation as a prime responsibility) and by the Forest Service with an assist from the Bureau of Land Management. Some private operators have developments on federal lands as is exemplified by the fishing camp operated by Northern Consolidated Airlines in Katmai National Monument, but more often the land is exploited through "homesteading", land patents, or simple outright use on an occasional and casual basis.

One of the most promising developments from the standpoint of the future auto tourist is the provision of camping sites and roadside recreational areas along the Alaskan highway network. The National Park Service completed proposed development programs in 1944 and in 1954 and the Bureau of Land Management spent about $235,000 between 1956 and 1959 in the improvement of some 47 out of a total of 106 developable sites. (6)

Although recognized as being quite necessary, the provision of private tourism developments has been very slow and is of minor importance. The few lodges, restored mining camps, ski slopes, and similar developments fall far short of the potentially developable and needed facilities according to the aforementioned studies. To some extent this underdevelopment stems from federal ownership of the land, a situation that would be substantially altered by the state's forthcoming acquisition of approximately one-third of the 365 million acres in Alaska as a privilege of statehood. At the same time it should be pointed out that Alaska's tourism is based mainly on wilderness features, the unspoiled (by man) face of nature, wildlife, solitude, privacy, unique natural history study areas, and the desire for individual aesthetic experiences. The very nature of the resource militates against massive tourist volumes, and a successful tourist promotional effort that came "too soon" might destroy the tourist resource base.

The remaining hindrances to a substantial tourist development program are the ever-present seemingly enduring factors of: great distances, lack of facilities, actual physical hazards (such as bears, climate, etc.), highly fluctuating demand accompanied by seasonality, limited investment funds, small nearby populations, poor service, high costs, and lack of an effective organization and a coordinated, adequately financed promotional effort. One of the most encouraging aspects of Alaskan tourism is the realization that the potential must be great indeed for tourism to grow and prosper in the face of the significant obstacles just mentioned.

There are indications that the travel business may be less robust in 1960 than it was in 1959 when Alaska had its best year.* Undoubtedly the free widespread publicity provided by statehood and the 1959 statehood celebration stimulated much tourist business. The 1960 "package tour" business operated at lower levels than in 1959, and this business is an important part of the total travel business.

* The tourist business was slower in the U.S., too, during the early part of the 1960 season. This condition has been attributed to a cool, damp, long, spring; a general slowing down or slight decline in the economy; or exaggerated disappointment following the exuberant economic forecasts of early 1960.

The indicated experience of one season bears little weight in the longer-term 20-year study period, but the coincidence in time of a less aggressive statewide tourist promotion program, following statehood, with the indicated reduced levels of tourism suggests a direct relationship that does have significance to Alaska's development of its tourism resource. From a marketing standpoint, travel is no different from any other consumer commodity. The consumer requires education and sales efforts in order to become a customer. Alaskan tourism deserves, and must have, a dynamic effective promotional program.

The Present and Prospective Use of Alaskan Tourism Resources

The present use of Alaska's tourism resource, then, is quite low for the reasons just enumerated. For instance, Katmai National Monument, although the largest area in the National Park and Monument system, only receives about 500 visitors per year. The second largest area, Glacier Bay National Monument, counts about 3,000 visitors but it is favored with regular stops by the summer tour ships. One might think that Mt. McKinley National Park, which is so strongly promoted by travel agents, would be the mecca of all Alaska tourists, but it only admitted slightly over 3,000 visitors a year until the Denali Highway opened in 1957, making the Park directly accessible to motorists. The Park was accessible by rail and air previously, and autos could be rail-shipped to the Park for travel on the Park Highway. But the opening of the Denali Highway, even in its unpaved gravel condition, has doubled Park attendance in 1 year.

This Park and these two National Monuments plus the very small Sitka National Monument taken together represent about 30 per cent of the total land area under the jurisdiction of the National Park Service in the U. S. The National Park Service forecasts that upon completion of the improvement and development programs under Mission 66 the attendance figures for these various areas for the year 1966 will be as follows: McKinley Park – 7,500+; Sitka National Monument – 40,000; Katmai National Monument – no estimate; and Glacier Bay National Monument – 10,000 to 15,000.

During 1959 the 180,000 acres in Alaska devoted to recreational purposes by the Forest Service experienced 780,000 visits for a total of 751,000 man-days by both Alaskans and outsiders. The projection of recreational demand for 1966 is 950,000 visits and 1,123,000 man-days. Corresponding projections for 1976 are 1,720,000 visits and 2,108,000 man-days. The use rates for the National Forest areas greatly exceed the rates for the National Park Service areas because the forests are much more accessible to Alaskan residents, and these visitors use them for picnicking, camping, and for summer residences.

A recent comprehensive analysis of the future demand for outdoor recreation resources shows that "The greatest increases in demand are likely to arise for the resource-based recreation lands. [Here] the prospective increase by the year 2000 is set at perhaps 40 times the present level."* But these outdoor recreation areas would suffer the most from overcrowding – the special wilderness attractions that draw people to the parks and forests would be greatly discounted. If this anticipated great increase in demand is projected against the available supply of these areas, it would seem that Alaska's resource-based recreational lands comprise an essential part of the future U. S. outdoor recreation resource. However, if these Alaskan areas are to be used, accessibility becomes a vital factor.

* Clawson, Marion, "The Crisis in Outdoor Recreation", American Forests (March, 1959, and April, 1959). Resource-based recreation areas are defined as those in which the natural qualities are most important.

Potential Increase in Travel and Tourism, 1960-1980

Economic growth is certainly one of Alaska's critical goals, and tourism is undoubtedly one of the area's major growth industries. The rapid growth of tourism would help broaden the very slim industrial base. "Tourism is an immediate and very important opportunity". (7a)

Alaskan tourism is being, and will be further, accelerated by: the population "explosion", increased leisure, longer paid vacations, more buying power (particularly in the discretionary-income area), the growing popularity of outdoor recreation, curiosity about the new 49th state, the increased mobility people are showing, dissatisfaction with older vacationlands, and improved accessibility. *

Seemingly the American tourist has providently just now reached the threshold necessary to achieve an Alaskan vacation. Growth prospects are good. According to one reputable source, "Tourism volume can be increased several times". (7b)

The measure of the level of opportunity is largely a matter of what takes place in the future rather than what can be seen or is known today. There are numerous ways to promote the travel business in Alaska:

(1) Schedule more tourist- or coach-rate flights on airlines serving the Area.

(2) Improve air schedules from the central and eastern parts of the southern 48 states.

(3) Improve courtesy and customer service – especially for outside visitors.

(4) Develop a greater variety of tourist activities – such as cog railways to scenic spots and snow tows and snow cats to places like the Juneau "ice cap".

(5) Build more and better accommodations available at lower rates, both in the areas between Alaska and the outside and in Alaska. **

(6) Educate tourists concerning means of minimizing risks of encounters with bears or other wild animals, of traversing mountainous trails, or of other physical hazards.

(7) Reduce the distance (time and cost) and discomfort of auto travel to Alaska.

(8) Provide more ways of getting to Alaska (car-ferry, rail-water-air, etc.).

* The average AAA member takes 1.7 vacation trips per year and 45 per cent take two or more. The average distance traveled on the major trip is 2,150 miles and the average vacation party is three persons. Three-fourths of all trips are two weeks or longer in duration. The Travel Habits of the AAA Member, American Automobile Association, Washington, 1960, p 5. U.S. Department of Labor statistics shows 82 per cent of union workers have 3 to 4 weeks' vacation.

** One of the reasons often given for high rates is that they are necessary due to the short season. If the efforts of the last several years successfully extend the season from May through September, these 5 months will equal the average period of U.S. recreation areas: A Review of the Outdoor Recreation Resources of the National Forests, "Work Plan For The National Forest Recreation Survey", U.S. Forest Service, Govt. Printing Office, Washington D.C. (August, 1959), p 33.

One of the most successful recent innovations in the U. S. entertainment field has been the Disneyland or Freedomland, U.S.A. type of development. Would not an "Arctic Land" be attractive to tourists visiting Alaska?

Future growth of Alaskan tourism depends upon the extent to which the three major limiting factors of distance, cost, and lack of development are overcome as they had to be overcome in Florida, Hawaii, and other tourist areas. No one can say what will happen, but a consideration of several alternative levels of potential tourism development suggests the probability of substantial growth. The available statistics on Alaskan tourism show increases during the past 5 to 10 years that average almost 7 per cent per year for both Alaskan travel and outdoor recreation. Foreign travel by U. S. tourists has shown growth rates of about 10 per cent per year. U. S. domestic tourism and recreation spending has been increasing at a lower annual rate of 5 to 6 per cent. Meanwhile, visits to the National Forests in the U. S. were 4 times as numerous in 1955 as they were 20 years earlier.

When the available statistics are examined in the light of foreseeable developments in Alaskan, U. S., and foreign tourism, and when all the other known pertinent factors have been considered in relation to the possible development of Alaskan tourism forecast by persons most knowledgable in this field, it is estimated that Alaska might count some 1,704,000 passenger movements (inbound and outbound total) in 1980. Attainment of this potential growth requires that the necessary improvements in the Alaskan tourism program are made. This four-fold increase in Alaskan tourism from 1960 to 1980 amounts to an average annual growth rate lying approximately midway (about 7 per cent per year) in the range of the indicator growth rates mentioned above.

Alaskan tourism promoters are well aware of what is needed. On November 20, 1959, Mr. Everett Patton, past president of the Alaska Visitors Association, appeared before the members of the Alaska Legislative Council with the following suggestions for improving Alaska's tourism program:

(1) Create a separate Department of Tourism

(2) Provide the Director with an Advisory Board representative of the industry

(3) Provide a budget that includes not less than $50,000 for national magazine and newspaper advertising, stressing "Drive Your Car to Alaska"

(4) Maintain a year-round active press bureau

(5) Insist that the Manager actively participate in the affairs of American Society of Travel Agents and the Pacific Area Travel Association

(6) Pass legislation to make answering the Hawaii "Port of Entry" type of questionnaire mandatory when entering Alaska

(7) Actively cooperatie with the State University Statistical Department and use the information for guidance

(8) Conduct tour host schools, stressing financial benefits to the individual

(9) Mimeograph a weekly progress report and mail it to every legislator.

In the past, only about one-third of Alaska's visitors were automobile tourists as contrasted with the fact that about 86 per cent of U. S. tourists drive their cars on their vacations.[8] Any practical attempt to put Alaskan tourism on a basis similar to U. S. travel would seem to require providing the American motor tourist with the conditions to which he is accustomed - pleasant, scenic, paved roads; and adequate, varied facilities at reasonable prices. In short, he must be given an opportunity to provide his family with an auto vacation.

If the American (and Canadian) tourist can be persuaded to come to Alaska in numbers approximating 850,000 travelers accounting for 1.7 million trips, it next becomes important to get some idea of how many people will use the various available transportation routes. The making of any such estimate is despairingly full of absolute imponderables, such as the provision of a new Southeastern Alaska ferry system; a new, shorter paved highway; and possibly a new railroad, the Pacific Northern Railway. Therefore, the estimates indicated in Table V-51 are meant to show only the order of magnitude rather than the absolute numbers of Alaskan travelers who might be expected to travel the various routes that seemingly would be available in 1980.

TABLE V-51. DISTRIBUTION OF ALASKAN TRAVELERS IN 1980 BY TRANSPORTATION TYPES

Transportation Type	Number of Round-Trip Travelers
Airlines	380,000
Highways (Alaska, Haines, and new routes)	370,000
Southeastern Ferry System	45,000
Canadian Ferry System	15,000
Steamship	40,000
Total All Types	850,000

This considered appraisal of how future travel will utilize the various routes shows important growth for all the travel media, with the automobile gaining the most, relatively, as has been true over the recent past in Alaska and the other states. The number of round-trip travelers using the airlines could increase over the quantity shown here quite easily if Alaska becomes the important polar air-transportation interchange many suggest.

The growth of Alaskan travel over the past 5 years undoubtedly resulted from a combination of statehood enthusiasm, unusual construction-worker and military-personnel (dependents) movement, and other causes that cannot be counted on to continue indefinitely. To maintain or exceed the past Alaskan rate many improvements in service and transportation facilities will be required. The improved transport facilities discussed in a later section of this report seem to provide a combination that should lead to a higher rate of growth than that of the past 5 years.

In considering the impact of new service and transport facilities on tourist activity it is necessary to examine the limitations of the present facilities. Those of major significance appear to be as follows:

(1) Narrow choice of mode of travel into Alaska and other areas of Northwest North America. The airplane does an excellent job, but excludes opportunity for a great number of Americans and Canadians that would like to see the area.

(2) Limited accessibility by surface transport of many towns, cities, and other points of interest. Many travelers like to see more of the area between various points of interest than an airplane ride permits.

(3) Inadequate accommodations along roadways and towns and cities. Building better motels, hotels, restaurants, and the like without reasonable assurance that the investment will pay off would be a risky business. Under present surface transport conditions only those in the larger cities dare take the chance.

(4) Almost 1200 miles of gravel road (Alaska Highway) with the discomfort of dust, and the hazard of chipped windshields and punctured tires and gas tanks.

With these limitations, as well as others that might be mentioned, it would be difficult to visualize more than a modest increase in travel in Northwest North America over the next 20 years. However, as will be seen, the expansion and improvement of the highway system, the installation of proposed ferry systems (Southeastern Alaska and Port Hardy-Kitimat-Prince Rupert-Stewart), extension of rail lines in British Columbia, and effective promotional efforts, constitute a formidable array of factors designed to overcome existing limitations and stimulate travel activity.

Battelle has projected travel growth to about 850,000 round-trip passenger movements by 1980 on the assumption that most or all of the suggested improvements will be made. Since some of these improvements, such as rail-line extensions, certain sections of road system, and one or more of the ferry systems are well along in the planning stage it has been assumed that these will be built and that they will stimulate travel. However, by themselves they add only a small degree of flexibility to the present travel system and may be expected to do more for local residents than for large-scale travel activity.

When other major transport facilities are improved or constructed, such as paving the Alaska Highway and building a shorter, scenic route from Hazelton, B. C., to Jakes Corner, the long-distance traveler, particularly the automobile tourist, will approach the idea of visiting the area with enthusiasm. Then the ferry systems, the various rail lines, and several feeder routes between new roads and the coastal area (Taku-Juneau and Iskut-Stikine-Petersburg), take on real significance. This improved transportation system, taken as a whole, then presents a number of variations for a trip that dispels the boredom of back-tracking on a long round trip, gives assurance of an uninterrupted travel schedule should one route become impassable, and provides a variety of scenic and other attractions to satisfy many individual tastes.

Assuming that the major recommended routes will do most of these things for tourists, and that feeder routes and ferry systems will provide the desired flexibility, it has seemed reasonable to conclude that there will be about 850,000 passenger movements yearly across Alaska's borders with these travelers spending an average of 17 days in Alaska. Of this number, Battelle has estimated that travel distribution will be somewhat as indicated in Table V-51.

Since it has been postulated that these travelers exclude local or intra-area travel, and that travelers on one part of the system on one phase of their trip may, and probably will, use another part of the system on another phase, the interdependence of the components of the system is obvious. The achievement of the levels of travel forecast is predicated on the creation of this whole transportation system. Although it is difficult to quantify the effect on total travel should one or more segments be omitted, it is not difficult to sense the reduction in drawing power that such omissions would produce.

The major components of this improved system will be the Alaska Highway (an established route from the dynamic growth areas in central and northwestern Alberta and northeastern British Columbia, and the large population areas in the U.S. and Canada, needing only a better surface to entice motorists), and the route from Hazelton to Jakes Corner (drawing from centers west of the Rockies). These two provide a significant opportunity for a circuit route for most of the possible trip to Alaska. Add to these one or more opportunities for travelers to reach Southeastern Alaskan cities, particularly the capital at Juneau, and greater assurance that motorists will make the trip is provided.

Effect of Origin of Highway Travelers

It has been demonstrated that the development of Alaska's tourism potential depends upon providing improved highway transportation for travelers from the major population centers of North America. In this regard, the origin of the highway tourists becomes quite important. Motorists from the areas west of the Rocky Mountains would probably be mainly interested in a new shorter land route located between Hazelton and Atlin. On the other hand, tourists from areas east of the Rocky Mountains would probably be more interested in a route generally along the axis of Edmonton and the Alaska Highway.

The inadequate and contradictory nature of Alaskan travel statistics considerably beclouds the question but the best estimate of the nature of Alaskan auto travel is shown in Table V-52. Already great numbers travel to Alaska from the West Coast states in the U.S. and provinces in Canada and the very great population concentrations in the eastern states and provinces establish that area as a valuable source of auto tourists for Alaska. It would seem that both areas require and would support improved highway connections with Alaska. In fact, as previously discussed, attaining the projected travel forecasted depends on the development of an improved transportation system that includes both routes.

TABLE V-52. PERCENTAGES OF AUTOMOBILE PASSENGERS, FROM THE SOUTHERN 48 STATES, LEAVING ALASKA VIA YUKON TERRITORY BY LOCATION OF CAR REGISTRATION, 1955-1959[(a)]

Year	States West of the Rocky Mountains[(b)]	States East of the Rocky Mountains
1955	38	62
1956	39	61
1957	43	57
1958	38	62
1959	39	61

(a) Source: Calculation from data supplied by Dominion Bureau of Statistics, Ottawa.
(b) Includes California, Oregon, Washington, Arizona, Idaho, Nevada, and Utah.

Potential Impact on Alaskan Economy

The potential impact that growth of the travel industry would make on the local economy is threefold: (1) new jobs are created requiring new workers, (2) these workers bring their families, thus adding to the population, and (3) since tourism is a product sold largely to people "outside" of Alaska, this activity brings new money into the State.

If Alaskan travel should increase from 194,545 round-trip passengers in 1960 to 850,000 in 1980, there might be as many as 14,610 new employees in Alaska whose major function would be to serve the "outside" traveling public. Additional payroll to these new employees is estimated at $87.6 million and total population growth of 87,660. Tourism expenditures in Alaska in 1960 are estimated at $66 million and these would be expected to approach $289 million in 1980 if the number of travelers reaches the forecasted 850,000.

Not only will this activity add substantially to the State's payroll but it will broaden and diversify the narrow industrial base. It will also cause considerable construction and capital investment in other forms. This analysis of the Alaskan tourism potential contains no examination of intra-Alaskan tourism activity. Such an analysis is beyond the scope of this study. However this activity represents an important part of Alaska's tourism picture.

One fact bears emphasis, however. The rate of growth will not be a straight line due to the differing impact and timing of such developments as lowered air fares, paved highway mileage, availability of ferry service, improved accommodations, accelerated tourist promotion programs, and the other developments previously mentioned.

Tourism in the Canadian Portion of the Area

The broad outlines of the tourism resources of this area resemble the Alaskan situation with the exception of the coastline, Inside Passage, island groups, and the remnants of earlier Russian life in several Alaskan areas. Possibly the most significant differences are that the southern parts of the Canadian portion of the Area are more accessible to large numbers of land-borne tourists and that tourism there is at a younger, less mature stage of development.

Considering the physical aspects first, this vast area is as geologically complex and intriguing as Alaska. Straddling the boundary of and including parts of the two physiographic divisions of the Interior Plains and the Canadian Cordillera (with its Rocky Mountains, Stikine Plateau, and Coast Mountains) there are offered to the future enterprising tourist such inspiring scenery as: The Grand Canyon of the Stikine River, the St. Elias Mountains (over 3 miles high), huge interior lakes (such as Kluane, Laberge, Atlin, Takla, Babine, Tagish, and Teslin), the Rocky Mountain Trench, appealing nearby camping and fishing sites such as the Kispiox River, and the numerous polar and arctic features (glaciers, permafrost, etc.) that have unusual interest to the midlatitude inhabitant. Again, the vastness, variety, and importance of the area deserves more than the general treatment possible here. The reader is referred to an outstanding available study.(9)

In addition to its spectacular beauty, Canadian scenery is nearer the U.S. traveler than Alaskan scenery. Much of it is directly accessible by various rather good transportation routes. For instance, the southern portion of the Canadian Rocky Mountains that lies within the study area is accessible from North Vancouver via the newly updated picturesque 730-mile-long Pacific Great Eastern Railway that reaches Fort St. John, 50 miles north of the southern terminus of the Alaska Highway.

Vancouver (or stateside) motorists may reach the same destination by traveling practically the same mileage over the largely paved Cariboo and John Hart Highways to the Alaska Highway terminus at Dawson Creek, B. C. Motorists from eastern North America (U. S. and Canada) have numerous alternative routes available but probably these two routes are most often chosen: (1) from Sweet Grass, Montana, the tourist rides 730 miles of paved highway to Dawson Creek, B. C., by way of Edmonton, Alberta; or (2) the tourist drives some 713 miles from Saskatoon, Saskatchewan via the paved Trans-Canada Highway 16 to Edmonton, Alberta, thence to Dawson Creek.

Rail passengers may reach this same area via connections with either the Canadian National Railway or the Canadian Pacific, as both of these transfer passengers to their jointly owned Northern Alberta Railway for continuation on to Dawson Creek.

Of course, air passengers readily reach the Canadian area, too, and cheaper and quicker than Alaskan-bound passengers reach their destination. This area has excellent air service from Canadian Pacific, Pacific Western, and Pan American Airways.

If these highway, air, and rail routes were not adequate, this area is also accessible by water from Vancouver via Prince Rupert from which point the passenger may ride the train, bus, or his own car east to Dawson Creek. Much the same sort of accessibility (except for longer distances and the lack of through rail connections) is true of the southern Yukon Territory area where visitors may arrive by plane, train, car, or bus.

In summary, then, much of the Canadian portion of the study area is more accessible in terms of time, comfort, and cost. One major and important exception is the northwestern portion of British Columbia, the area between Hazelton, Finlay Forks, Dease Lake, and Atlin.

The Canadian portion of the study area evidences even less development of its vast tourism resources than Alaska. The "package tour", that has been so successful in Alaska, is less often the means of attracting the tourist to this area. The most notable exception to this is the tour arranged to use the Canadian National Railway to Prince Rupert, thence by the Canadian National Railway cruise ship to Skagway including a ride to Whitehorse on the White Pass and Yukon Railway. Undoubtedly, there exist opportunities to substantially increase this side of the tourist business.

Another reflection of the stage of development is in the number, type, and variety of tourist accommodations and activities available. Whereas there are adequate lodging and eating facilities, there is very little tourist-oriented development (parks, ski resorts, large hotels, etc.). There are numerous small motels, fishing camps, roadside picnic areas, gasoline service stations, and other individual-type developments. However, the variety provided by the full range of facilities and activities offered by more mature tourism areas is lacking. Although the natural attributes are there, this area has no Sun Valley, Banff National Park, or National Monument areas.

In fact, even the tourist promotion agencies are young. In British Columbia, where the emphasis has long been on southern British Columbia where there are parks and the highest population concentrations, there is just now being developed the awareness of the need for a regional tourist promotion agency. Local boards of trade and travel bureaus have until now carried the burden of developing the tourist business. In

Yukon Territory, there are now at least two rather young but very enthusiastic and active groups: at Whitehorse there is the Yukon Travel Bureau (partly government supported) and at Dawson there is the Klondike Tourist Bureau and the Klondike Visitors Association. In July 1960, the Canadian Minister of Northern Affairs and National Resources announced the establishment of a Northwest Territories Tourist Office situated in Ottawa. Their program will include the promotion of sport-hunting of buffalo near Fort Smith. There is also to be established a Northwest Territories Tourist Association.

The situation in Alberta is more nearly like British Columbia - the southern part of the province demands and receives the most attention - there is an active, capable, provincial tourism program that is heavily oriented toward the motor tourist, outdoor recreation seeker, and week-end visitor.

This Canadian portion of the study area contains 1,221 of the 1,526 miles of the Alaska Highway from Dawson Creek to Fairbanks. The route is a unique experience in driving long distances through wilderness country of dense spruce and birch forests in the southern or Canadian Rockies portion where the highest point on the highway is reached at Summit Lake* (mile 392) where the elevation is 4,156 feet. Some 100 miles further north on the highway, the traveler encounters "Paradise Valley" where hot springs in the vicinity of Toad River gorge and the Liard River help produce tropical flowers and vegetation.

Further along, the tourist arrives in Whitehorse, capital of the Yukon, an authentic frontier mining and communications center. Whitehorse has many interesting tourist attractions - Indian culture, Takhini hot springs (20 miles away), the steamer Yukoner (one of the last of the gold-rush flotilla), Miles Canyon and Whitehorse rapids that claimed many a gold seeker as well as Chief White Horse who gave his name to the community, and Sam McGee's cabin made famous by the writing of Robert W. Service. Fish and game, both big and small, are available plus spectacular scenery enough for any camera enthusiast. Destruction Bay at mile 1083 is a graveyard of gold-rush-day boats and the Million Dollar Mile at mile 1545 is noteworthy for having been surfaced with the tailings from the Tenderfoot Creek gold strikes.

Canada, like Alaska, is doing many things to promote and develop its tourist business in the Northwest North American Area. The Caravan 97 group in traveling this year from Bend, Oregon, to Dawson Creek, will do much to publicize approach roads to the Alaska Highway, especially for U. S. motorists. There are other tourist promotions that may well prove attractive to the U. S. and Canadian tourist in the period 1960-1980.

First, there is the suggested "Inland Sunshine Route to the South" that extends from Fairbanks through Reno, Nevada to Tehuantepec and the Mexico-Guatemala border. This route has been further extended to San Jose, Costa Rica, as part of a so-called "North America Route 1" utilizing the Inter-American Highway that has cost some $253 million to construct ($171 million paid by the U. S.). [10] The ultimate plan envisions Circle, Alaska, as the northern terminus of a hemispheric highway extending through North, Central, and South America. If such international continental routes actually became a part of tourism by 1980, they would certainly open up many new opportunities for a greatly expanded tourism economy in North America.

* Not to be confused with Summit Lake north of Prince George, on the John Hart Highway.

Potential Impact on Economy of Canadian Area

Increased travel to Alaska and to the Canadian portions of the study area are expected to have a significant impact on the economy of this part of northwestern Canada by 1980. But it should be clearly understood that the impact indicated as being possible in this area depends upon the full development and promotion of the tourism program in Canada as well as in Alaska, and on provision of the transportation system mentioned previously.

This portion of Canada is even more undeveloped than Alaska, and tourism statistics suitable for reliable forecasts 20 years into the future simply do not exist. The projected impact of tourism discussed below has been developed through reasoned nonstatistical inference considering: (1) all known facts, (2) information obtained from the area's Boards of Trade and travel organizations, and (3) interpretations based on ratio analysis of analogous Alaskan and Canadian situations.

It is estimated that in 1960 this area hosted about 125,000 round-trip tourists who spent approximately $27.4 million*. Battelle's analysis of the growth possible from a greatly improved tourist development (parks, improved accommodations at reasonable prices, etc.) and promotion program plus the provision of the transportation system suggested in this report indicates that by 1980 there might be as many as 561,000 Alaska-bound travelers spending $73 million in Canada plus an estimated 550,000 travelers going only to Canada spending $110 million for a total expenditure of $183 million in Canada. This increased annual expenditure of $156 million would require an additional 7,005 workers accounting for $35,025,000 worth of new tourism payroll and a total new population increment of 42,030 persons.

This analysis of tourism potential contains no examination of the tourism activity of the residents of the area. Such an analysis would be beyond the scope of this study, but this activity would represent an important part of northwestern Canada's tourism picture in 1980.

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(2) "A Six-Year Integrated Program for the Department of Interior in Alaska, 1952-1957", Alaska Field Committee, U. S. Department of the Interior, mimeo (1957), p 1.

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* 1960 U.S. dollars used throughout the tourist section.

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(9) Bostock, H. S., "Physiography of the Canadian Cordillera, With Special Reference to the Area North of the Fifty-Fifth Parallel", Canada Department of Mines and Resources, Geological Survey Memoir 247, Ottawa (1948).

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VI. RESOURCE-BASED MANUFACTURING AND RELATED INDUSTRIES

In essence this chapter summarizes the potential effects of resource development on the economy of Northwest North America as derived from the analyses in the preceding chapter. However, a limited number of other industries and services are included that are not directly related to natural resources but that might be expected to develop or expand with population increases and general economic development. Table VI-1 summarizes the increases in population, in tonnage output, and in value of product estimated for each of the resource developments to 1980; Table VI-2 gives present and projected values of product in resource-based industries, and total population, 1958 and 1980. These projections are based only on plausible developments from known resources in the Area, and do not include possible developments that might result from new discoveries of resources (mainly metals, minerals, and fuels) made in the future. In making population estimates a 1 to 6 ratio – basic workers to population – was used. This ratio was derived by assuming that each new worker in a basic or manufacturing industry will be matched by the equivalent of one new worker in all the secondary or service industries, including construction, and that each of such two workers will have two dependents.

In the very early stages of a region's development, particularly under "normal" conditions as contrasted to some form of "emergency" situation, the products of agriculture, mining, or other extractive industry are all that the region has to offer in trade for the necessities of life. As is well known, some regions have great difficulty getting beyond this stage, while others with more resources or special talents progress to great economic health and wealth. And it takes people with pioneering spirit, durability, daring, and love of the rugged to develop the North Country. Many such people have been drawn to the Area and many more will follow. Others among them, with perhaps a less deep-seated pioneering spirit, will become disillusioned and disenchanted with the rigors of frontier life and will leave as soon as possible. Those who really love it will stay on to swell the numbers that make up the backbone of a dynamic and growing Northwest North America.

Basically, Alaska and northern parts of Canada are in the "very early stages" of development, even though they are segments of two highly prosperous nations. In the latter sense these northern regions are more fortunate, politically and economically, than small countries such as the Latin Americas. Alaska, northern British Columbia, and the Yukon and Northwest Territories may be able to make more rapid progress than the conventional underdeveloped countries because of the support that their federal governments can and must provide to maintain and strengthen national prestige, and a more attractive "business climate" than offered by many underdeveloped foreign countries.

But such actions alone will not be enough if the economic stature of Northwest North America is to become impressive. In spite of new roads, railroads, geological and forest surveys, hydroelectric plants, and other federal and state financed projects, private industries must be developed on a large scale if the north country is to attain significant growth in population and a tax base of sufficient breadth to pay for additional development and government services. Moreover, private industries cannot operate without markets that can be served on a competitive basis. For a number of industries,

TABLE VI-1. ESTIMATED INCREASES IN POPULATION, ANNUAL OUTPUT, ANNUAL VALUE OF PRODUCT, AND PAYROLLS THROUGH RESOURCE DEVELOPMENT, BY 1980

	Alaska					Yukon and Northwest Territories					Northern British Columbia					Northwestern Alberta				
Industry	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase	Annual Output, short tons unless noted otherwise	Value, millions of dollars	Number of Basic Workers	Payroll Increase, $000	Population Increase
Metals and Minerals																				
Iron Ore	2,925,000	23.0	950	–	5,700	–	–	–	–	–	–	–	–	–	–	350,000(2)	25	500	–	3,000
Copper	270,000	40.0	900	–	5,400	–	–	–	–	–	411,000	61.0	1,600	–	9,600	–	–	–	–	–
Lead, Zinc, Silver	–	–	–	–	–	70,000	8.0	300	–	1,800	30,000	5.0	100	–	600	–	–	–	–	–
Tungsten	–	–	–	–	–	2,500	3.2	150	–	900	–	–	–	–	–	–	–	–	–	–
Mercury	500	2.5	100	–	600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asbestos	–	–	–	–	–	30,000	8.0	400	–	2,400	–	–	–	–	–	–	–	–	–	–
Nickel and Copper	–	–	–	–	–	8,000	3.0	50	–	300	–	–	–	–	–	–	–	–	–	–
Limestone	1,500,000	1.5	100	–	600	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total Metals and Minerals	4,695,500	67.0	2,050	13,700	12,300	110,500	22.2	900	4,850	5,400	441,000	66.0	1,700	9,200	10,200	350,000	25	500	2,100	3,000
Coal	1,000,000	10.0	400	4,000	2,400			Minor					Minor					Minor		
Oil	25 million bbl	60.0	3,500	32,000	21,000			Unknown			50 million bbl	120.0	5,000	26,000	30,000	55 million bbl	132.0	3,500	18,600	21,000
Gas	100 billion cu ft	15.0									400 billion cu ft	60.0				153 billion cu ft	23.0			
Forest Products																				
Pulp	600,000	90.0	3,500	26,000	21,000			Minor			525,000	81.0	3,100	13,000	18,600	420,000	63.0	2,410	8,700	14,460
Lumber	66 million bd ft	6.6	600	3,900	3,600						213 million bd ft	21.3	1,980	6,600	11,880	213 million bd ft	21.3	1,980	6,600	11,880
Fish (Catch)	200 million lb	14.0	None	14,000	None			Nil			90 million lb	8.0	None	8,000	None			Nil		
Agriculture	–	35.0	1,300	13,000	7,800			Minor			–	4.0	–	–	None	–	16.0	–	–	None
Tourism	–	223.0	14,600	87,600	87,600	–	51.0	2,840	11,700	14,040	–	99.0	4,390	21,950	26,340	–	5.5	275	1,375	1,650
Miscellaneous																				
Food processing	–	10.0	1,000	6,600	6,000			Unknown					Unknown					Unknown		
Electro process (1)	1,245,000	62.2	1,250	9,600	7,500	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cement	500,000 bbl	3.0	70	400	420	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total miscellaneous	–	75.2	2,320	16,600	13,920	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total, all resources	–	595.8	28,270	210,800	169,620	–	73.2	3,240	16,550	19,440	–	459.3	16,170	84,750	97,020	–	285.8	8,665	37,975	51,990

(1) Includes pig iron, steel and calcium carbide. Value shown for pig iron and steel represents value added by manufacture, not including value of iron concentrates shown at top of table.
(2) Steel.

TABLE VI-2. PRESENT AND PROJECTED VALUES OF PRODUCTS IN RESOURCE-BASED INDUSTRIES, AND ESTIMATED TOTAL POPULATION 1958 AND 1980[a]

	Value of Indicated Products, millions of dollars									
	Metals and Minerals	Coal	Oil	Gas	Forest Products	Fish (Catch)	Agriculture	Tourism (Expenditures)	Total	Population
Alaska										
1958	21.4	7.0	Minor	Nil	27.0	33.1	4.7	66.0	159.2	224,000 (1960)
1980	88.4	17.0	60.0	15.0	123.6	47.1	39.7	289.0	755.0[b]	393,620[b]
Yukon and Northwest Territories										
1958	11.8	Minor	1.0	Nil	Minor	Nil	Minor	5.9	18.7	12,200 (1956)
1980	34.0	Minor	Unknown	Unknown	Minor	Nil	Minor	57.0	91.0	31,640
Northern British Columbia										
1958	9.8	Minor	1.0	3.9	117.0	49.6 (1956)	7.7	7.0	196.0	57,700 (1956)
1980	75.8	Minor	121.0	63.9	219.3	57.6	11.7	106.0	655.3	154,720
Northwestern Alberta										
1958	Nil	Nil	12.9 est.	3.6 est.	16.0	Nil	32.6 (1956)	14.5	79.6	70,000 (1956)
1980	25	Minor	144.9	26.6	100.3	Nil	48.6	20.0	365.4	121,990
Total in 1980	223.2	17.0	325.9	105.5	443.2	104.7	100.00	472.0	1,866.7[b]	701,970[b]

(a) Source: Bureau of the Census, Dominion Bureau of Statistics, Alberta Bureau of Statistics, British Columbia Bureau of Economics and Statistics, Battelle estimates.
(b) Total value of product and total population figures for Alaska and Area in 1980 include $75.2 million and 13,920 persons, respectively, arising from food processing, electroprocessing and cement manufacture shown in Table VI-1.

Note: Above estimates, especially of population, assume continuation of military and Government activities at about 1959 levels for the period 1960-1980.

markets in the U. S. and Canada are beyond competitive range either because of distance or differentials in production costs between existing eastern industries and potential producers in the Northwest. So, in the initial stages of development, at least, Northwest North America must look elsewhere for opportunities to trade. "Trade" involves both exports and imports, as will be developed further in this section.

Dollar values on commodities given in subsequent paragraphs are based on 1960 prices* even though discussion refers to 1980. Payrolls are based on 1957 wages.

Alaska

Metals and Minerals

The development of metals and minerals from known deposits could provide total annual increases in tonnage and value of some 4.7 million tons and $67 million, respectively, by 1980. Battelle has estimated that such increased production of metals and minerals, comprising iron ore, copper, mercury, and limestone would increase population by about 12,000 persons. Basic workers, numbering 2,000, would collect total annual wages of about $13 million (1957 wage rates), using $128 per week for a 50-week year. Average weekly earnings in Alaskan industries are shown in Table VI-3.

Coal

The future of the coal industry in Alaska is uncertain in that competing fuels and hydro power already threaten its present base in its principal use – production of electricity. However, it is postulated that production of steam coal for use in Alaska and of coking coal for export to Japanese or other markets may increase the annual tonnage produced by 1 million tons by 1980. The dollar value would be $10 million, and new population created would be 2400 persons. The 400 coal miners involved would earn total annual wages approximating $4 million, assuming $191 per week during a 50-week year.

Oil and Natural Gas

By 1980, new annual production of oil and gas may reach 25 million barrels (valued at around $60 million) and 100 billion cubic feet (valued at around $15 million), respectively. Apparently there is little question that such quantities would be available; but such production will depend strongly on development of markets at competitive prices. For some years, it is anticipated that the principal markets will be in the Pacific basin, notably Japan for potential gas sales and the West Coast U. S. for oil products. Limited local industrial markets in Alaska would have to be shared between these two fuels and compete with coal and hydro power for some uses. Population increase derived by gas and oil production is estimated at 21,000. The 3500 industrial workers would earn wages estimated at $32.0 million for a 50-week year and $180 per week, average wage. These figures could be greatly increased by discovery of

*Except for natural gas, which is escalated at 1/4 cent per million cubic feet per year for 20 years above the approximately 10-cent average price of 1960, or to 15 cents per million cubic feet in 1980.

TABLE VI-3. ALASKA: AVERAGE WEEKLY WAGES IN INDUSTRIES COVERED BY UNEMPLOYMENT INSURANCE, 1957[a]

[In dollars]

Industry	All Alaska	Southeast	South Central and Interior	Northern and Western
All industries	131	100	141	124
Mining	148	116	161	112
Metals	128	107	136	114
Coal	191	0	196	(b)
Crude petroleum, natural gas	181	0	180	0
Contract construction	210	150	215	231
Building, general	203	147	208	249
Other, general	246	171	253	(b)
Special trade	181	127	185	(b)
Manufacturing	126	117	128	154
Salmon canning	117	94	120	155
Lumber and wood products	131	132	128	(b)
Pulp, paper, paperboard	148	148	0	0
Transportation	107	84	117	80
Trucking and warehousing	100	78	107	(b)
Air transportation	138	126	141	(b)
Water transportation	81	60	92	78
Communication, utilities	163	109	173	(b)
Trade	106	77	114	58
Wholesale	143	95	148	(b)
Retail	97	75	104	58
Finance, insurance, real estate	106	97	108	(b)
Service industries	91	65	98	56
Other industries	102	107	101	(b)

(a) Source: "Financing Alaska's Employment Security Program", Alaska Employment Security Commission.
(b) Not computed; base less than 25.

additional major oil deposits in the next 20 years. Conversely, they could fall far short of these estimates if development lags or markets cannot be reached at competitive prices.

Forest Products

Pulp production by 1980 could show an increase of 600,000 tons, valued at $90 million. Some 21,000 persons would be added to the population, and the 3500 new workers in this industry would earn about $26 million in annual (50-week) wages at the 1957 rate of $148 per week.

Lumber and other wood products may increase by 66 million board feet per year valued at $6.6 million. Those employed in this production would number 600, earning $3.9 million at $130 per week for 50 weeks. Population would be increased by 3600 persons.

Fish

As was brought out in the fisheries section, an over-all increase of 200 million pounds in quantity of fish caught annually by 1980 would mean an increase of $14 million in value of catch. However, no increase in workers or population is anticipated. As fishermen are paid on a basis of shares of the catch, individual incomes would be enhanced by the greater production; so, except for itinerant fishermen's income, virtually all of the $14 million would enter the local economy as spendable income. Cannery workers associated with processing the increased catch would also show little, if any, increase in numbers, would be paid by the canning companies on the basis of $117 per week (average 1957 weekly wage), and would work either longer hours, more days per week, or a greater number of weeks. Wages paid to cannery workers are in addition to the $14 million earned by fishermen. Many of the cannery workers, however, are moved in from Washington and California for the canning season, and do not stay long enough to spend much of their earnings in Alaska.

Agriculture

Some 1300 new farm workers may enter the agriculture picture by 1980, and produce $35 million worth of additional farm products. These farm workers may well not net anything approaching the $24,000 apiece that the $35 million per 1300 implies, but their expenditures on equipment, seed, fertilizers, insecticides, and other supplies would contribute heavily to Alaska's economy; some of this money, however, would go to wholesalers back in the southern 48 states. The remainder, comparable to "spendable income" of other types of workers, would enter the area's wage picture. Conservatively, this "spendable income" might be computed on the basis of $10,000 annually per farm worker or $13.0 million. Population increase stemming from increases in farm workers would amount to an estimated 7800 persons.

Tourism

By 1980, tourism might employ 14,600 new employees over the present estimate of 4,297 in Alaska. The population increase attributed to these new employees would then be 87,600, and their payroll contribution to the State's economy may approach $87.6 million. The travel business, as calculated in the Tourism section, may rise from the present estimated annual level of $66.0 million to $289 million by 1980.

Other Industries and Services

No estimates or prognostications comparable to those attempted for the preceding basic industries can be justifiably quantified for other imaginable Alaskan industries. However, it is reasonable to assume that as the economy of Alaska expands, enterprising Alaskans and others will see opportunities to set up operations to supply or draw from basic industries and to render needed services to the growing population. Some examples are suggested in the following paragraphs; others will occur to the observant.

Food Processing. Considering Alaska's (and other areas in Northwest North America) almost complete dependence on outside sources for food supplies, it is natural to look toward food processing for new business opportunities. A number of such operations are now being carried out in a small way – bakeries, dairies, poultry farms, and the like. A start has been made on a brewery that with adequate capital may yet become a reality.

When agricultural endeavors become more extensive, processing (freezing and canning) of vegetables, meats, and fruits should become feasible, although severe market limitations will be serious obstacles. Manufacture of ice cream, butter, margarine, salad oils and dressing, detergents and soaps, and a variety of other products could follow.

Bottling of wines and spirits shipped to Alaska in bulk (barrels or tankers) would be feasible long before fermentation plants or distilleries would be appropriate. It may be expected that the bottling of carbonated beverages will increase as a function of increasing population and consumption rates.

Flour milling based on local grains is not likely to develop extensively for many years to come. However, in the interim it might be feasible to set up a few relatively small, specialty milling operations based on imported grains. Alaska now imports from the 48 states some 5,000 tons of flour and an unknown quantity (tonnage included in grocery-shipments data) of prepared baking mixes, breakfast foods, and the like; the latter, being nationally advertised brands in the main, would present a local miller with too formidable competition to suggest this as a promising field. However, he should be able to make out as well as, if not better than, many of the small millers operating in other regions, supplying bakeries and housewives with standard brands of wheat flour. Regional bakeries for fresh and "hard" baked goods may be expected to appear when appropriate population concentration levels have been reached.

Total employment in the food-processing industries suggested would hardly exceed 1000, for a very rough estimate, by 1980. A payroll increase of about $6.6 million could be produced, and product value added of about $10 million.

Electrochemical and Electrometallurgical. During the course of the study no plans by large companies were uncovered nor was any great enthusiasm displayed for establishing electroprocessing plants in Alaska. Whether or not interest in such operations may develop over the next 20 years will depend to a considerable extent on: growth in local demand, availability and low cost of raw materials, the world market, transportation and labor costs, and other factors. It will also depend on the availability of low-cost power (under 5 mills per kwhr) in large blocks, with power facilities financed and constructed by other parties.

Chlorine and caustic soda for the existing pulp plants, and for others that will be built, can be shipped readily and cheaply from the Puget Sound area. The decision to make these in Alaska would probably be made more readily by one or more of the pulp companies, if made at all, than by a chemical company who would have the problem of finding markets in addition to the pulp mills; the pulp company could use the chlorine directly as gas and would not have to invest in costly compressors, storage, and transportation equipment to make and handle liquid products. Any one of the chlorine processes (including nonelectrolytic) that might be used by a pulp mill would add very little to the employment picture, at most one or two operators for each installation.

Calcium carbide production, requiring lime, coke, and electricity, would provide employment for about 40 men (4.6 man-hours per ton)[1] for a 20,000-ton-per-year (300 days) plant, a size that might be appropriate for Alaska to supply possible local markets and an export market. Population would be increased by 240 people, and payrolls by some $400,000. Coking coal (low in ash content) and lime (virtually free of phosphates and magnesium carbonate) would have to be available locally, and near to cheap power. This combination may exist in the Bering River area, but the true situation must await more detailed investigation.

In the discussion of iron in the "Metals and Minerals" section, it was pointed out that iron-ore concentrates from Snettisham and Klukwan might be electric-smelted to pig iron or to steel, with assumed production of 500 tons per day and 3000 tons per day of pig iron or steel, respectively. Such operations would employ an additional 200 and 1000 men, respectively; produce products valued annually at $8.5 million and $73.5 million, respectively; and give additional payrolls for the industrial workers of around $1.6 million and $8 million, respectively. Population would be increased by a total of some 7200 persons.

Aside from these, too little is known about the quality and quantities of undiscovered minerals to permit speculation on growth possibilities associated with electroprocessing in Alaska. The possibility of importing suitable grades of ores or concentrates, such as bauxite, chromite, manganese, phosphates, and others for conversion to metals and ferroalloys for export and future local use does not look promising, as indicated under discussion of potential markets for hydroelectric power. Gaseous-diffusion plants might be built or moved from existing locations in the southern 48 states, to relieve possible shortages of energy there, although this appears quite impractical.

Cement. The recently announced decision of Kaiser Permanente Cement Company to build a 500,000-barrel-per-year, $5 million cement plant near Anchorage will certainly cover Alaska's needs for cement in the next 20 years. The estimated 100 employees for this plant may not be counted as totally new additions to the labor force, since Permanente has been shipping in bulk cement that is bagged at Anchorage; bagging operations in the new plant would employ the same or an equivalent number of men. On the basis of say 70 additional men, a 50-week year, and $120 per week, new payroll

(1) Faith, W. L., Keyes, D. B., and Clark, R. L., Industrial Chemicals, John Wiley & Sons, Inc., New York (1957), p 35.

would be about $400,000. Population growth of about 420 people might stem from operations of the cement plant. Important tonnage now carried or that might have been shipped in by Alaska Steam and several barge lines will be subtracted from the latter's ocean-freight business, except for any that may be shipped out of Anchorage by water.

Petroleum Refining, Petrochemicals, and Fertilizer. For a number of years, any likelihood of refining petroleum or producing petrochemicals in Alaska would depend on export markets. This would be courting possible disaster when local production in those export-market areas becomes economic by virtue of low-cost importation or discovery of basic crude materials -- oil or gas. Manufacture of certain petrochemicals, such as ammonia, ammonium nitrate, urea, etc., for fertilizer requirements in Alaska and in the Far East, and for that matter in Hawaii, now supplied from California, may prove feasible. Production of these petrochemicals, at least, would more likely be based on natural gas than from refinery off-gases and would be well established long before the first refinery is built. About 50 employees and a payroll of $500,000 would arise from a medium-sized ammonia plant. These, plus employees in a petroleum refinery and liquefied-natural-gas plants, are included under "oil" and "gas" in Table VI-1.

Fertilizer production would be confined to nitrogen variations, since natural gas appears to be so plentiful whereas phosphates and potash are not. It would be desirable for Alaska if a company that had established markets in California, Hawaii, and other Pacific areas took on the production of nitrogen products in Alaska, particularly if the manufacturer, like Brea Chemicals, will soon need additional sources of natural gas.

Summary

Adding up all these resource-based industries and their possible contributions to Alaska's economic growth, we find that this is best shown in tabular form (Table VI-1).

The more significant numbers in this table are those showing a total population increase resulting from resource-based industries of about 170,000 persons, and increased payrolls in these industries of about $210 million annually by 1980. In addition to the direct industrial payroll increases, there should be an almost equivalent amount paid to the supporting activities and services, since the assumption has been made that one industrial worker generates the need for one secondary industry and service worker. A total payroll increase, then, of $420 million would maintain a high per capita income of $2100 (1957 dollars). Total value of new product of basic industries has been estimated at $596 million annually. This increased production indicates a total production in 1980 of $755 million, as shown in Table VI-2.

These numbers could be quite conservative if new major discoveries and developments of the resources involved should come about, although there are included in the above estimates some highly conjectural metal and mineral developments. Also, drastic changes in the military and construction picture could greatly influence such operations as coal mining, cement manufacture, lumbering, and others. The outcome of foreign-trade promotion and negotiation, particularly with the Far East, could have a considerable effect on the minerals, forest products, fertilizer, petrochemicals, and other industrial developments. Changes in military and Government activities could also affect substantially the population estimates, which are based on assumed continuation of the military program and personnel at about 1959 levels.

Imports, too, can have a significant bearing on the development of Alaska. As is well known, Northwest North America has some difficulty in obtaining materials at prices low enough to permit a cost-of-living index reasonably comparable to that nearer to heavily populated areas of Canada and the southern 48 states. Much of the onus has been placed on exorbitant transportation costs or on labor rates or both. If transportation costs are to blame, then labor rates must be high enough to permit workers to purchase higher priced necessities. If labor rates are abnormally high because of competition with "well-heeled" military purchasers or short working seasons or overgenerous unemployment-compensation provisions, or because of all three, arbitrarily lowering transportation costs would not remedy the situation.

Freight tariffs now in effect between the 48 states and Alaska do not encourage – and in fact preclude – some types of processing or fabricating plants in Alaska. For example, rates on flat metal sheets are identical with those on steel culverts. However, it may be properly assumed that when the demand for fabricated steel products reaches a high enough volume in Alaska, it will be possible to negotiate a delivered price on flat metal sheets sufficiently below those for fabricated products imported from the 48 states to permit competitive fabrication in Alaska.

Setting up active trade relations with the cheapest source of raw materials, construction materials, household goods, and foodstuffs available could go a long way toward decreasing cost of living in the North Country, particularly in Alaska. Bearing in mind that Alaskans want to be sure of high quality, low maintenance cost products, considerable care should be exercised in cultivating low-cost sources.

Examination of records of British Columbia imports from the Orient does not indicate many similar items that would be of help to Alaska's economy. The items included under "Iron and Its Products" in these records would be the most appropriate as a starter. Regardless of whether Japan buys pulp, coal, or iron ore from Alaska, for example, the latter might do well to buy semimanufactured or fully manufactured products from Japan, if by so doing some reduction in cost of living would be realized. As two-way trade opportunities develop and increase between Northwest North America and Japan and other Far Eastern countries, the broader the economic base of the former can become. The first direct importation of a shipload of steel, consisting of 4,000 tons of "reinforcing bars, flat and corrugated galvanized sheets, galvanized water pipe and nails" arrived at Anchorage from Japan on May 15. This may seem a small beginning, but it could well be a harbinger of a greater future trade. Gas- or oil-well casings might be logical items for import from Japan if oil and gas developments in the future prove successful.

Although internal transportation and connection with the southern 48 states are not involved to any appreciable direct extent in the development of these resources, the population increases, the attraction of permanent workers, and the importance of the tourist trade demand that new land-transportation facilities be pushed as rapidly as possible.

British Columbia, Yukon and Northwest Territories, and Northwestern Alberta

Metals and Minerals

Analysis of Table VI-1 indicates that several mineral activities in this area might provide employment increase, by 1980, of 3,100 workers, and a payroll increase of $16.7 million. Their efforts could produce annual tonnages of steel, copper, lead, zinc, silver, tungsten, asbestos, nickel and other minerals or concentrates totaling 900,000 tons valued at $113 million. A population increase of over 18,000 would stem from such an industrial growth.

Oil and Gas

Potential developments in oil and gas have been estimated for northern British Columbia and northwestern Alberta, only. Totals of 105 million barrels of oil, and 553 billion cu ft of natural gas are shown in Table VI-1. These are valued at $252 million, and $83 million, respectively. A total of 8,500 new workers, receiving $44.6 million in wages would be required to produce these fuels. A population increase of 51,000 would be associated with this industrial activity.

Forest Products

Pulp and lumber production would also be confined to northern British Columbia and northwestern Alberta. Estimated increases of 945,000 tons in production of pulp, and 426 million bd ft of lumber have been made. Total values for these products would be about $187 million, with total payrolls of $34.9 million. New workers would number 9,500 and population increase would total 57,000.

Fish

British Columbia would increase its catch of fish by 90 million pounds, annually, by 1980, indicating an added value of catch of $8 million over present values, and thus a payroll increase equivalent of $8 million. Much of the fishing activity is below the area included in the study, but for the purposes of this analysis no attempt to separate these out seemed necessary or desirable.

Agriculture

Current farm employment and capacity seem adequate to produce an increase in value of farm products amounting to about $20 million annually for northern British Columbia and northwestern Alberta.

Tourism

Increased tourist activity, stimulated by transportation improvement and promotional efforts in northwestern Canada, as well as in Alaska, may increase total tourist business in the Canadian area from a currently estimated $27.4 million to 183.0 million per year, by 1980. New employment associated with tourism would be approximately 7,000, with a payroll increase of about $35 million. Population increase involved would be 42,000.

Wholesale Trade and Services

It may be said that as a forerunner to various of the resource-based industry developments anticipated or hoped for, wholesale distribution of presently needed commodities will expand and that of newly developed and needed commodities will be an important function in Northwest North America. The cement picture described in the Alaska section is an excellent example of how such transitions from need to wholesaling and distribution to manufacturing occur. It is quite obvious, therefore, that the wholesale distributor and the transportation companies must be alert to new commodities to fill gaps that are created by ultimate manufacture; and they must be constantly on watch for a likely switch from importing to manufacture. Again, the case of the cement situation is quite illustrative; a company recently set up to compete with Permanente's cement importing and distributing business finds the pattern completely changed virtually overnight!

Summary

The increases stemming from these resource developments in northwestern Canada are shown in Table VI-1, and the effects on total values of industrial products and on population are shown in Table VI-2.

Total population increase resulting from resource-based industries may amount to 168,000, and increased payrolls in these industries could total $139 million, by 1980. On the basis of a 1:1 ratio of basic workers to supporting or related workers, there would be an approximate total payroll increase of $278 million. Total value of new products for basic industries has been estimated at $818 million annually, which would result in an annual total value of product by 1980 of $1,112 million for Northwest Canada.

New major discoveries or developments of the resources discussed could change these figures quite measurably upward, while failure to realize full development could mean falling short of these estimated gains, of course. Since a major component of the totals is the hoped for increase in tourism, segments of northwestern Canada have an incentive to cooperate with each other and with Alaska in providing the best possible facilities and promotional effort to encourage tourism.

VII. PRESENT AND PLANNED TRANSPORTATION FACILITIES

Present Facilities

Freight movement into and out of the northwest portion of Northwest North America is predominantly waterborne, with only air and long-haul truck transport as very minor competitors. Total tonnage amounts to something over 2 million tons, three-fourths of which is inbound, and half of this is tanker movement of liquid fuels. Data illustrating this movement in 1958, not including tonnages moving into and out of the Peace River area, are as follows:

	In	Out
Waterborne		
Dry Cargo		
Commercial	540,000	327,000[(a)]
MSTS	183,000	88,000
White Pass & Yukon	85,000	65,000
Tanker (fuels)	721,000	65,000
Overland Truck	5,000	2,000
Air		
Commercial	8,700	2,600
MATS	6,000	4,800
	1,548,700	554,400

(a) Includes 150,000 tons of pulp shipped in bond out of Ketchikan.

By far the most important transportation media on a tonnage basis, in Northwest North America, are the water carriers – notably Alaska Steamship Company, White Pass and Yukon Route, Alaska Barge and Transport, Incorporated, and an assortment of tow-barge operators. Linked to these carriers are the rail and trucking lines that move the waterborne commodities on into interior points and bring the much smaller quantities of exportable commodities to the ports served by the water carriers. Figure VII-1 identifies major land transportation routes and services. Notable among these land transportation operators handling this port traffic are the Alaska Railroad, White Pass and Yukon rail and truck lines, Garrison Fast Freight, Puget Sound Alaska Van Lines, and Alaska Northern Express, Incorporated. Straight-through overland freight haulage via Alaska Highway and connecting highways in British Columbia and Alberta is carried on by a number of individual truckers and trucking companies; Lynden Transfer, Incorporated, is the major U. S. operator in this category and others are: Herda Alaska, James Burke and Company, Arctic Motor Freight, McCahill Trucking, and Martin Van Lines.

Several airlines, including Northwest Airlines, Pan-American World Airways, Northern Consolidated Airlines, Alaska Airlines, Canadian Pacific Airlines, Pacific Western Airlines, and Pacific Northern Airlines connect Alaskan and Yukon cities with major Canadian and U. S. centers. Additional lines, Reeve Aleutian Airways, Alaska Coastal Airlines, Wien Alaska Airlines, Ellis Airlines, Cordova Airlines, and non-scheduled charter planes serve Alaska and the Yukon internally. Finally, there are

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several freight- and passenger-boat operations on the Yukon (Northern Commercial Company, Yutana Barge Lines, and Weaver Brothers) and Kuskokwim Rivers (Sam Parent, Eugene Tibbs and Snow Transportation Company) during the few months of the year when these rivers are free of ice. "Cat" trains travel over frozen ground, rivers, and lakes during the wintertime to many areas that would be inaccessible in warmer months.

Water Transportation

The Alaska Steamship Company is the predominant water carrier operating between Seattle and the Alaskan ports of Seward and Valdez. The stops made by its ships at ports in Southeastern Alaska and at small ports elsewhere along the coast of southern and western Alaska are incidental, tonnagewise, to its main service areas. Typical schedules provide for service once a week from Seattle to Southeastern Alaska and twice a week to Seward; the latter schedule is reduced somewhat during winter months because of reduced activity, mainly construction, and hence lower freight shipments.

Annual tonnages shipped via Alaska Steam to Alaska amount to about 300,000 tons, of which about 75 per cent is shipped to Seward for trans-shipment by the Alaska Railroad to Anchorage and Fairbanks. Shipments to Seattle from Alaska via Alaska Steam are limited to about one-third of total tonnage handled. Over its 65-year history, Alaska Steam has increased the number of its ships to 15, and has attempted to improve its services and to maintain reasonable rates. Use of large unitized containers and vans is a recent improvement, but an economic feasibility study of car-on-deck trainships indicated high initial construction costs and hence the probability of higher rather than lower shipping costs, as had been hoped for.

In spite of efforts such as these, transportation costs, including combined ocean and rail rates and wharfage and handling, have increased roughly 15 to 30 per cent, depending upon commodity, in the period 1948-1958 (Table VII-1). Further increases of 10 per cent for the water carriers were announced late in 1959 and were the subject of Federal Maritime Board hearings in mid-1960.

Table VII-2, showing waterborne shipments of consumer, industrial, and "dual purpose" commodities from mainland U. S. to Alaska in 1952 and 1957, sheds significant light on the limited opportunities for many competing carriers to each obtain adequate payloads; data in this table does not include shipments in vessels of less than 1000 tons and in non-self-propelled vessels. Deleting tanker-carried fuels, and commodities (including fuels) carried by military vessels, some 450,000 to 500,000 tons of general cargo remain. Of these latter quantities, only some 200,000 to 250,000 tons of commodities such as cement, lumber products, iron and steel products, and miscellaneous building materials lend themselves to bulk handling, preferably by towed barge. A few of the higher value commodities can be carried in containers or vans aboard barges, and this mode of transportation is being used at the present time. But the lack of significant backhaul tonnage minimizes the full advantage of such operations, and hence the expectation that present transportation costs can be greatly reduced. The facilities and services of Alaska Steam are most adaptable to such general backhaul cargo as is available (roughly 30 per cent of total dry-cargo shipments). Seasonal southbound cargo, such as canned and frozen fish and special southbound freight, such as pulp from Ketchikan, do not constitute regular return cargoes that can be reliably coordinated with northbound service.

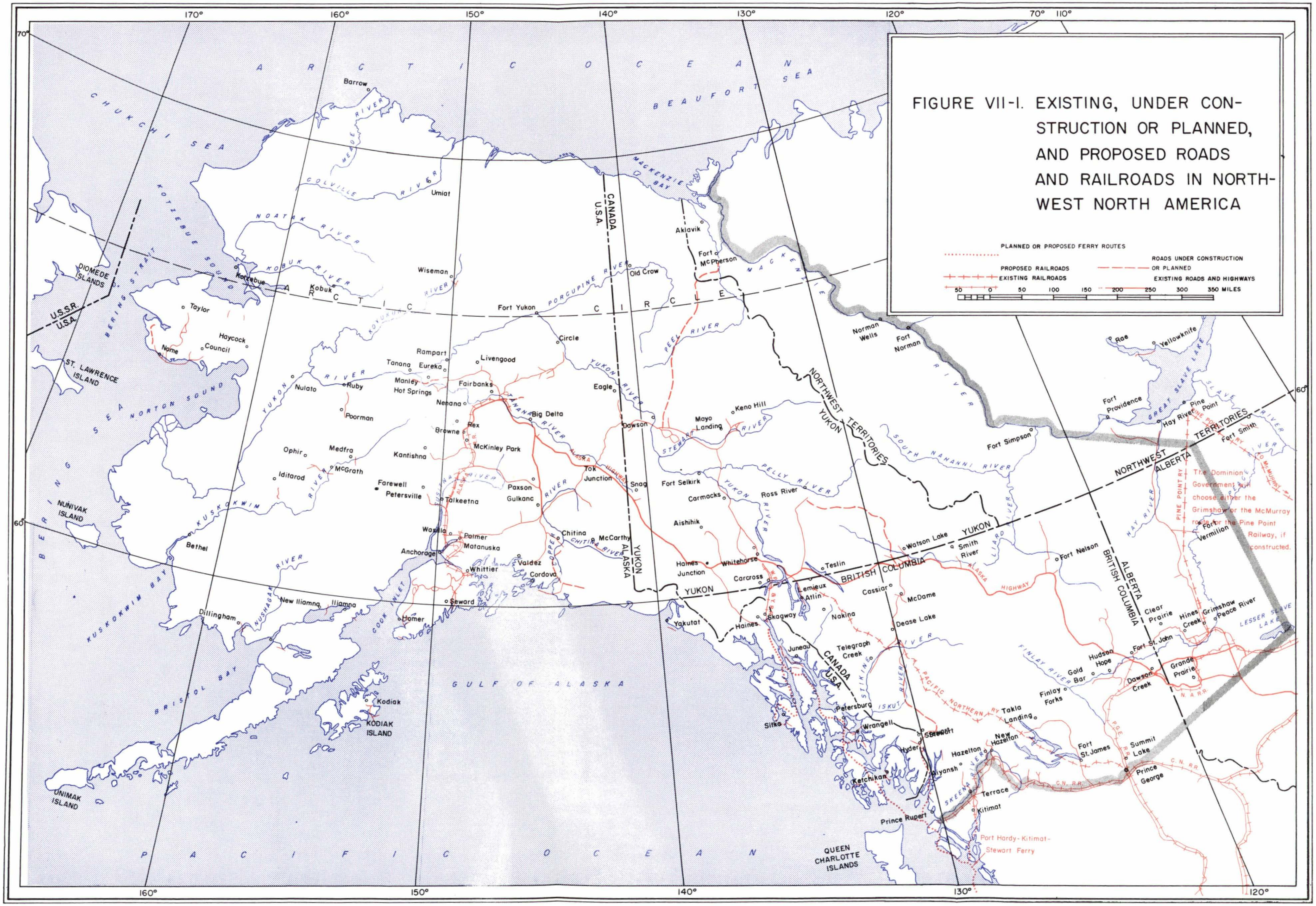

FIGURE VII-I. EXISTING, UNDER CONSTRUCTION OR PLANNED, AND PROPOSED ROADS AND RAILROADS IN NORTHWEST NORTH AMERICA

TABLE VII-1. TRANSPORTATION CHARGES PER HUNDRED WEIGHT FOR SPECIFIED COMMODITIES IN CARLOAD LOTS BETWEEN SEATTLE AND PALMER OR FAIRBANKS, AUGUST 1948 AND 1958[a]

	Palmer				Fairbanks			
	1948		1958		1948		1958	
Commodity	Steam and Rail	Wharfage and Handling	Steam and Rail	Wharfage and Handling	Steam and Rail	Wharfage and Handling	Steam and Rail	Wharfage and Handling
Lumber	$1.39	$0.08	$1.86	$0.07	$1.69	$0.08	$2.26	$0.07
Roll roofing	2.70	0.10	2.95	0.15	3.81	0.10	3.37	0.15
Wallboard	1.80	0.10	2.21	0.12	2.36	0.10	2.78	0.12
Cement and plaster	1.49	0.08	1.84	0.12	1.88	0.08	2.26	0.12
Iron and steel	2.70	0.10	2.99	0.15	3.81	0.10	3.61	0.15
Agricultural implements	1.30	0.10	1.91	0.15	1.30	0.10	2.23	0.15
Vehicles	6.75	0.15	9.40	0.23	7.20	0.15	10.40	0.23
Grain and grain products	1.83	0.10	2.30	0.15	2.27	0.10	2.80	0.15
Potatoes	1.96	0.10	2.39	0.15	2.64	0.10	2.85	0.15
Groceries								
Soups, canned fruit, etc.	2.69	0.10	2.64	0.15	3.81	0.10	3.32	0.15
Coffee, bakery goods, etc.	2.69	0.14	2.86	0.22	3.81	0.14	3.54	0.22
Perishables	5.85	0.10	6.27	0.15	7.82	0.10	7.05	0.15
Citrus fruits and apples	2.84	0.10	4.31	0.15	3.96	0.10	4.11	0.15
Fresh meat	5.62	0.10	7.00	0.15	7.18	0.10	8.15	0.15
Gasoline	1.60	0.12	2.08	0.16	2.43	0.12	2.96	0.16
Fuel and diesel oils[b]			2.01	0.15			2.89	0.15
Fertilizer[b]			2.06	0.12			2.39	0.12
Hay and straw[b]			2.37	0.15			2.87	0.15
Percentage of increase over 1948 (average)			22	45			11	45

(a) Source: Alaska Railroad, private communication.
(b) Omitted in the 1948-1958 percentage comparisons.

TABLE VII-2. DOMESTIC OCEANBORNE TRADE FROM MAINLAND (U. S.) TO ALASKA[(a)]

In Tons of 2,000 Pounds

Commodity	1952	1957	Commodity	1952	1957
		Consumer Goods			
Animal, edible	74	22	Fruit and preparations, canned	1,895	2,504
Meat, fresh or frozen	10,012	16,754	Fruit, fresh or frozen except		
Meat, canned	183	212	bananas	3,709	6,863
Meat, otherwise prepared			Fruit, canned	--	2,504
or preserved	929	3,598	Fruits, otherwise prepared	4	--
Animal oils and fats, edible	57	26	Bananas, fresh	--	4
Condensed and evaporated milk	2,796	2,063	Fruit juice, canned or frozen	--	4
Dried milk and solids	232	561	Nuts and preparations	--	64
Cheese	3	26	Vegetable oils and fats, edible	--	180
Other dairy products	2,300	4,255	Other cocoa, chocolate, coffee	666	--
Fish, fresh or frozen	2	11	Sugar	2,560	2,419
Fish, canned	16	1	Molasses, edible honey, syrup	112	201
Fish, otherwise prepared			Distilled spirits, malt liquors	21,593	23,477
or preserved	45	3	Other beverages and syrups	536	921
Shellfish and products	--	14	Other groceries and food	40,708	65,390
Eggs and egg products	541	1,930	Tobacco, manufactured	555	710
Other animal feeds	1,106	4,351	Seeds, except oilseeds	79	140
Corn	3	50	Animal feeds (other)	5,548	738
Wheat flour and semolina	5,477	3,228	Medical and pharmaceutical		
Oats	71	7	preparations	75	130
Other grains	646	569	Synthetic fibers and other textile		
Vegetables, fresh or frozen	7,142	15,911	products	--	492
Vegetables, canned	2,124	3,690			
Other vegetables and preparations	328	25	Total	112,127	164,418
		Industrial Goods			
Other animal products, inedible	7	5	Iron and steel castings and forgings	714	205
Vegetable products, inedible	3	28	Tools and basic hardware	7,365	5,396
Vegetable oils, fats, etc., inedible	--	28	Other textile products	410	--
Cotton mfrs., cotton rags	176	341	Other metal mfrs.	23,704	19,425
Burlap and jute bagging	11	7	Aluminum metal and alloys	268	130
Vegetable fiber, semi-mfr.	154	127	Copper or concentrates	16	32
Posts, poles, and piling	18,867	13,410	Copper and copper-base alloys,		
Box crate plywood, etc.	5,981	6,324	semifabricated forms	231	1,509
Lumber and shingles	37,191	25,086	Refined copper	--	4
Other wood mfrs.	5,120	11,000	Lead and lead base alloy	--	15
Railroad ties	--	3,996	Electrical machinery	3,760	4,560
Cork and mfrs.	61	15	Engines, turbines, and parts	1,178	361
Standard newsprint paper	814	868	Construction mach., excavating		
Other paper and related products	--	5,055	and mining machinery	6,974	16,161
Petroleum, asphalt, and products	14,784	21,681	Other industrial machinery and parts	8,050	4,292
Building cement	6,880	64,316	Machine tools and metal-working		
Building monument and other			machinery parts	7	8
stone	2,076	1,983	Agricultural machinery	68	163
Clays and earths	107	333	Merchant vessels and parts	2,446	1,050
Limestone	--	200	Aircraft and parts	12	29
Sand, gravel, and crushed rock	340	250	Railway locomotives, cars, and		
Gypsum or plaster rock			parts	2,754	1,198
(including gypsum cement)	--	30	Coal-tar products	--	234

TABLE VII-2. (Continued)

Commodity	1952	1957	Commodity	1952	1957
		Industrial Goods (Continued)			
Other nonmetallic minerals	7,328	12,051	Industrial chemicals	8,046	37,746
Sulfur	--	2	Sulfuric acids	18	--
Iron ore and concentrates	50	--	Pigments, paints, and varnishes	929	4,064
Iron and steel scrap	57	--	Miscellaneous chemical products	1,153	2,765
Iron and steel semifinished products	2,962	982	Other fertilizer materials	910	2,071
			Nitrogenous fertilizers	217	--
Pig iron, including sponge iron	--	28	Synthetic fibers and mfrs.	95	--
Rolled and finished steel-mill products	35,155	32,523	Total	207,449	302,087
		Goods for Dual Purposes			
Leather and manufactures	3	37	Glass and glass products	883	871
Rubber tires and inner tubes	560	651	Brick and tile	2,305	1,922
Other rubber manufactures	20	478	Other clay products	353	--
Wood manufactures	9,449	8,749	Salt	1,664	3,097
Other paper products	11,194	--	Autos, trucks, and buses	8,641	8,807
Wool – semi-mfr. and mfr.	--	43	Parts for autos, trucks, buses, trailer parts	1,105	1,651
Bituminous coal and lignite	2,152	1,364			
Coal and coke briquets	35	11	Other vehicles and parts	4,781	2,358
Motor fuel and gasoline	174,545	210,472	Naval stores, gums and resins	1	--
Gas, oil, and distillate fuel	314,256	424,863	Hospital and household utensils	--	6
Kerosene	3,215	7,289	Other commodities	--	75,728
Residual fuel oil (inc. bunker)	76,440	3,639			
Lubricating oils and grease	5,927	39,822	Total	763,839	816,478
Other petroleum products	11,809	23,617			
			Grand Total	1,083,415	1,282,983

(a) Source: "The Alaska Market", J. Walter Thompson Co. (1958).

Table VII-3 gives the total tonnages of tanker and large vessel dry-cargo shipments by origin and destination in Alaska's domestic waterborne commerce for the period 1950-1958. In addition to the tonnages represented in this table, there were in 1958 some 250,000 tons of dry cargo shipped to Alaska and 61,000 tons shipped from Alaska by self-propelled vessels of less than 1,000 gross tons and by non-self-propelled barges.(1) Also, there were about 150,000 tons of pulp shipped "in bond" on train-barges by Ketchikan Pulp Company from Ward's Cove via Prince Rupert to eastern U. S.; shipments of pulp and lumber from Sitka to Japan are not included in these tonnage data. Although principally a Canadian movement, it is interesting to note that 85,000 tons of general cargo inbound and 65,000 tons of lead and zinc concentrates and asbestos fiber moved through Skagway, Alaska; this is considered to represent virtually all tonnage for Yukon Territory and Northern British Columbia. Figure VII-2 shows the trend in waterborne shipments between Alaska and the West Coast of the U. S. from 1950 to 1958, with totals for 1958 that include shipments by vessels of less than 1000 gross tons and by barges, as well as by the larger ships featured in earlier data. It is apparent that dry-cargo shipments by the larger vessels has dropped steadily from 1950, with strong indications that smaller vessels and barges have taken over much of the lost tonnage. Figures VII-3 and -4 show typical flow of general cargo into and out of Alaskan ports.

River shipping is, in essence, an internal transportation network similar to existing rail and highway routes. However, it is even more seasonal than the latter, and over a period of years fluctuates more drastically in its activity. Tonnage of shipments on Alaska's rivers in recent years has been on the order of 30,000 to 50,000 tons, predominantly for the military.

During the few months that they are free of ice and floods, the Yukon, Kuskokwim, Tanana, Mackenzie, Peace, Liard, and Stikine Rivers among others have borne explorers, prospectors, promoters, adventurers and pleasure seekers, and their supplies, for many years. When frozen they provide bridge crossings and trails for dog-sled, "cat" tractor sled trains, and foot traffic. The rivers provide relatively cheap water transportation for mining equipment and supplies, and a limited amount of export of minerals and furs to and from interior points in Alaska, Yukon and Northwest Territories, and British Columbia. The seasonality of their usefulness means that careful advance planning in preparing shipments in or out is essential. If a boat departure is missed or some part of a shipment is overlooked, operations may be held up for a long and costly time; oversupply adds to already high inventory costs; undersupply may mean discomfort, hunger, or suspended or cancelled operations. All of these add up to the high cost of doing business in the interior.

Where newer, faster forms of transportation have been developed to points traditionally served by riverboats, the latter have curtailed service or gone out of business entirely. Special situations, requiring a large movement of heavy equipment (such as for a single mining operation or for drilling a gas or oil well), may be taken care of by a barge or boat constructed for the purpose or brought from another waterway if the river to be used lacks adequate service. Except where dams or reservoirs may be built that would obstruct free passage of riverboats, the rivers will always be available for transportation whenever anyone finds it more economical to go into the interior by water. If the day should come when great industrial activity flourishes along extensive stretches of any of the rivers in Northwest North America, modern tow-barge systems will be seen operating there.

TABLE VII-3. DOMESTIC OCEANBORNE COMMERCE BETWEEN THE WEST COAST OF THE UNITED STATES AND ALASKA, 1950-1958[a]

In Tons of 2,000 Pounds

Origin, Destination, Type of Ship, and Commodity	1950	1951	1952	1953	1954	1955	1956	1957	1958
Grand total	1,410,523	1,376,506	1,227,356	1,052,469	1,123,375	1,159,264	1,284,322	1,144,238	1,106,516
Total in tank ships	(b)	519,392	573,676	465,563	605,114	671,825	781,540	695,992	700,993
Total in dry-cargo ships	(b)	857,114	653,680	586,906	518,261	487,439	502,782	448,246	405,523
Grand total	1,410,523	1,376,506	1,227,356	1,052,469	1,123,375	1,159,264	1,284,322	1,144,238	1,106,516
Total to Alaska	1,210,517	1,214,999	1,076,638	939,092	999,479	1,063,610	1,170,547	1,048,682	980,631
From California	603,207	545,200	606,166	481,872	625,028	696,061	801,614	710,728	682,673
In tank ships	(b)	506,909	554,489	448,165	591,180	659,461	771,594	679,613	673,316
In dry-cargo ships	(b)	38,291	51,677	33,707	33,848	36,600	30,020	31,115	9,357
From Pacific Northwest	607,310	669,799	470,472	457,220	374,451	367,549	368,933	337,954	297,958
In tank ships	(b)	12,258	19,187	17,398	10,924	12,361	9,946	15,425	18,205
In dry-cargo ships	(b)	657,541	451,285	439,822	363,527	355,188	358,987	322,529	279,753
Total from Alaska	200,006	161,507	150,718	113,377	123,896	95,654	113,775	95,556	125,885
To California	2,592	8,614	5,385	1,508	4,139	2,020	4,463	8,087	13,210
In tank ships	(b)	--	--	--	3,010	--	--	954	9,472
In dry-cargo ships	(b)	8,614	5,385	1,508	1,129	2,020	4,463	7,133	3,738
To Pacific Northwest	197,414	152,893	145,333	111,869	119,757	93,634	109,312	87,469	112,675
In tank ships	(b)	225	--	--	--	3	--	--	--
In dry-cargo ships	(b)	152,668	145,333	111,869	119,757	93,631	109,312	87,469	112,675

(a) Dry-cargo ships of 1000 gross tons and over. Does not include shipments in self-propelled vessels of less than 1000 gross tons, those in non-self-propelled barges or tankers, or pulp from Ketchikan to eastern U. S. via Prince Rupert, B. C.

(b) Breakdown between dry-cargo and tank ships not available.

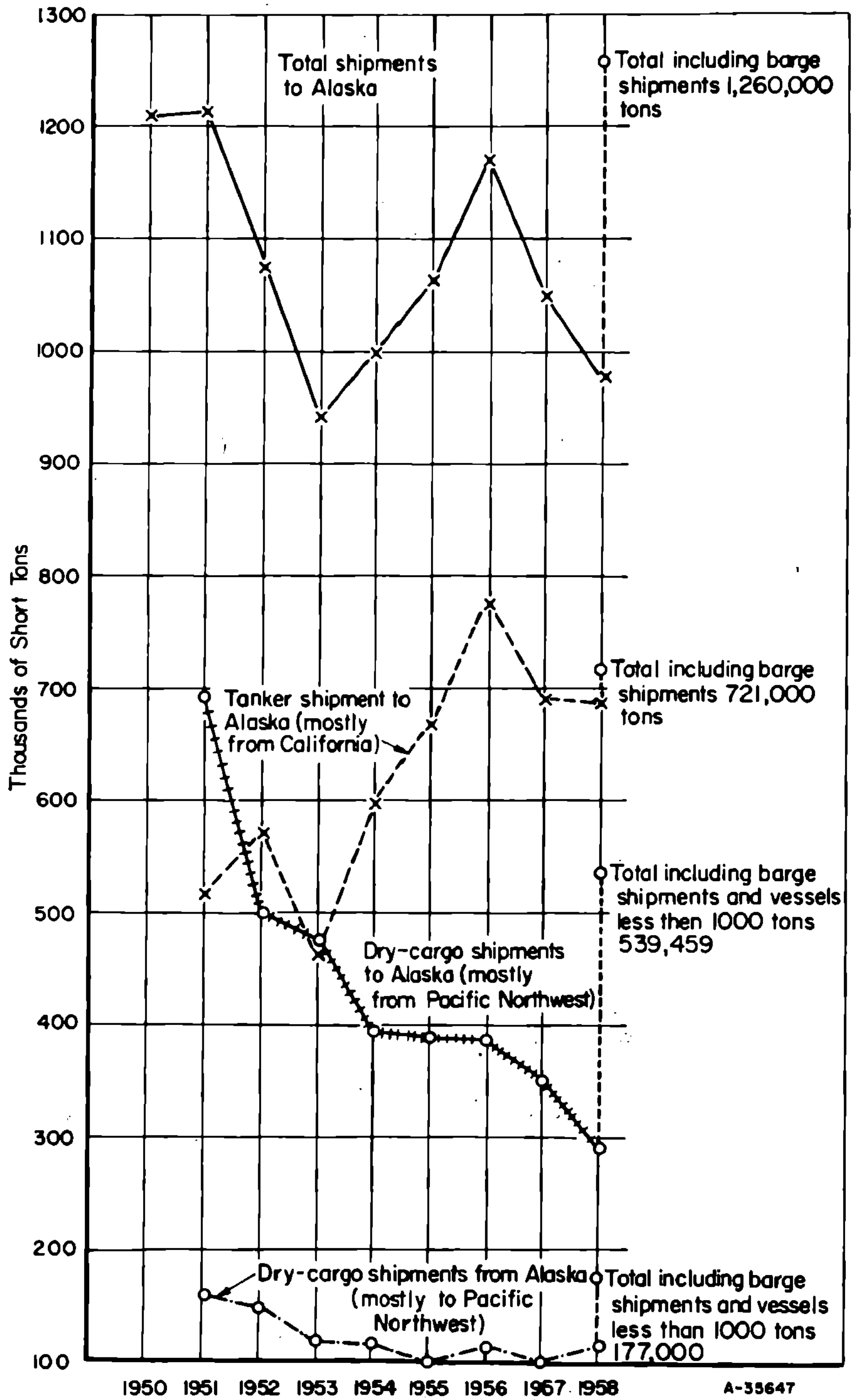

FIGURE VII-2. DOMESTIC OCEANBORNE COMMERCE BETWEEN THE WEST COAST OF THE UNITED STATES AND ALASKA, 1950-1958

Source: Docket 881, "Alaskan Traffic Pattern During the Past Decade", General Services Administration, June 27, 1960, Maritime Administration, April 25, 1960.

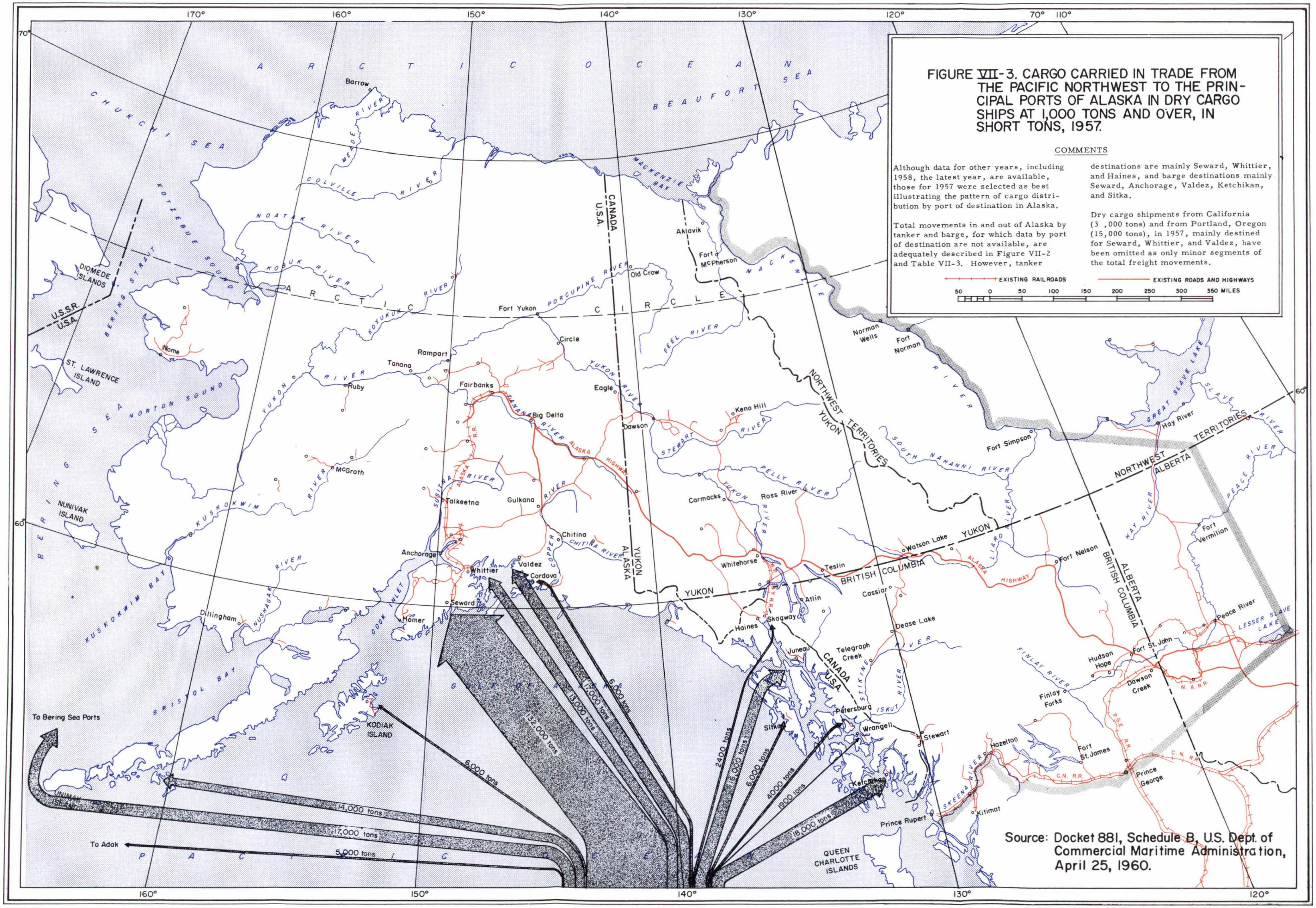

FIGURE VII-3. CARGO CARRIED IN TRADE FROM THE PACIFIC NORTHWEST TO THE PRINCIPAL PORTS OF ALASKA IN DRY CARGO SHIPS AT 1,000 TONS AND OVER, IN SHORT TONS, 1957.

COMMENTS

Although data for other years, including 1958, the latest year, are available, those for 1957 were selected as best illustrating the pattern of cargo distribution by port of destination in Alaska.

Total movements in and out of Alaska by tanker and barge, for which data by port of destination are not available, are adequately described in Figure VII-2 and Table VII-3. However, tanker destinations are mainly Seward, Whittier, and Haines, and barge destinations mainly Seward, Anchorage, Valdez, Ketchikan, and Sitka.

Dry cargo shipments from California (3 ,000 tons) and from Portland, Oregon (15,000 tons), in 1957, mainly destined for Seward, Whittier, and Valdez, have been omitted as only minor segments of the total freight movements.

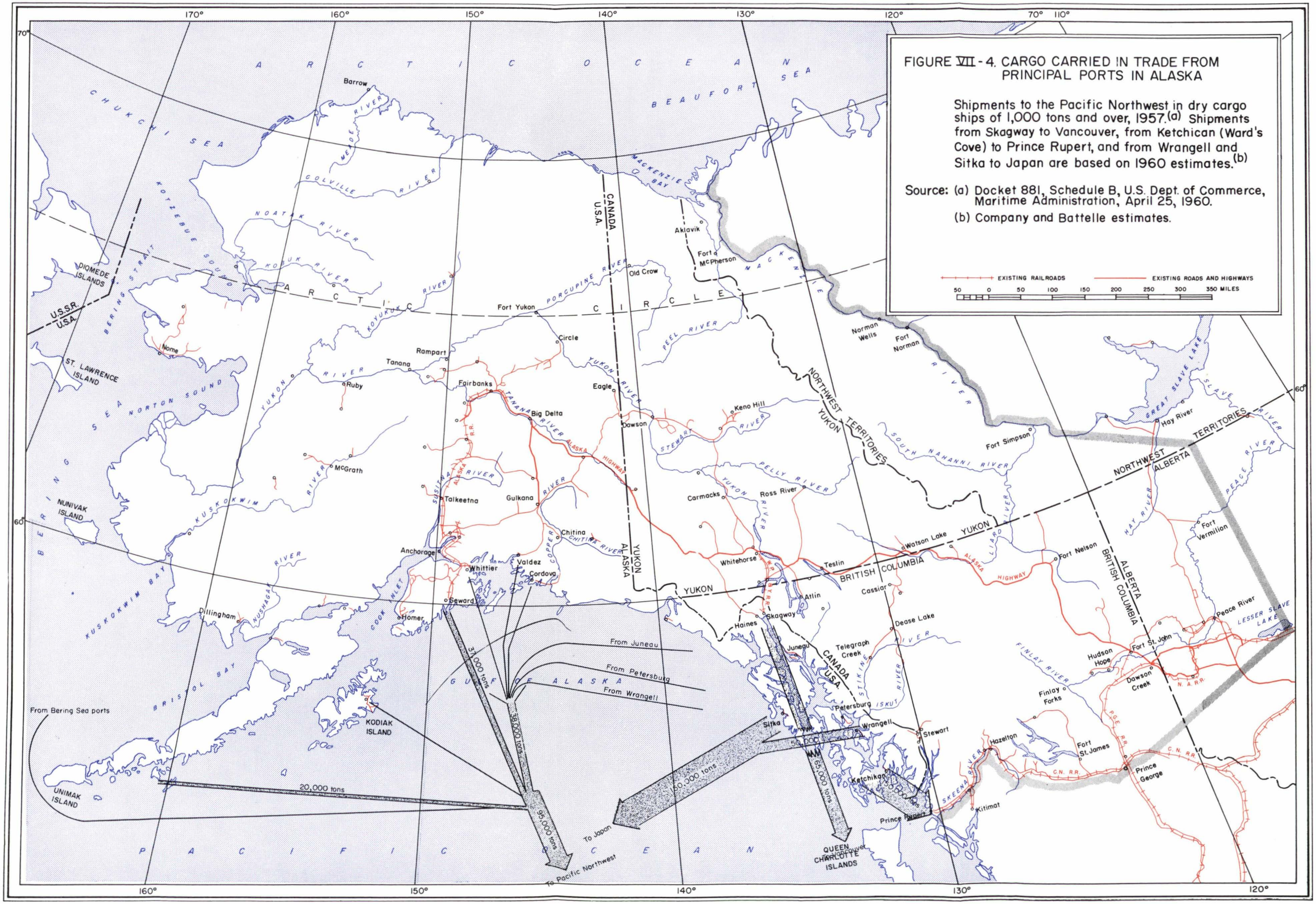

FIGURE VII - 4. CARGO CARRIED IN TRADE FROM PRINCIPAL PORTS IN ALASKA

Shipments to the Pacific Northwest in dry cargo ships of 1,000 tons and over, 1957.[a] Shipments from Skagway to Vancouver, from Ketchican (Ward's Cove) to Prince Rupert, and from Wrangell and Sitka to Japan are based on 1960 estimates.[b]

Source: (a) Docket 881, Schedule B, U.S. Dept. of Commerce, Maritime Administration, April 25, 1960.

(b) Company and Battelle estimates.

Land Transportation

Land transportation in Northwest North America has shown a pattern in which trails and roads represent the greatest mileage and least tonnage, while railroads are short in mileage but high in tonnage (Figure VII-1). The widely scattered villages in this vast area – products of a series of gold rushes, fur trapping and fishing activities, and sporadic development of mining operations in isolated areas – justified little more than the most primitive means of communication, with frequent short roads leading only to the nearest river as shown in Figure VII-1. More recently, the airplane took over the role of the dogsled, canoe, and snowshoe, thus making a paradoxical leap from the primitive to the modern, while omitting or postponing the traditional evolutionary steps from trail to road to highway or railroad. In the limited areas of population concentration, railroads have been built, such as between Fairbanks and Anchorage in Alaska, and where resource development has seemed to justify it, such as from Vancouver and Prince Rupert to Prince George and Fort St. John in British Columbia, or Skagway to Whitehorse, Yukon Territory. For a time, there was a railroad up the Copper River from Cordova to serve the operations of the rich but depleted Kennecott copper mine.

Highways have been built primarily as a result of military or defense needs, particularly beginning with World War II; most of the traffic on these highways has continued to be associated, for the most part, with needs of defense-related and/or other Government activities, although mineral development and production and tourist travel have augmented traffic on these transportation arteries.

The Alaska Railroad, solely in Alaska, handles the most tonnage of Northwest North American railroads, followed by the Pacific Great Eastern Railway operating from Vancouver to Fort St. John and Dawson Creek in British Columbia, the Northern Alberta Railroad in northwestern Alberta, and the White Pass and Yukon Route from Skagway, Alaska, to Whitehorse, Yukon Territory. The Canadian National Railway traverses the southern boundary of the study area from Prince Rupert to Prince George and eastward, and thus plays an important part in servicing the area.

Alaska Railroad. The Alaska Railroad is the "backbone" of Alaska's surface-transportation system. From 50 to 60 per cent of its revenue tons comprise military shipments, mainly coal. The railroad's principal dollar volume is in commercial freight and miscellaneous shipments for Government agencies. Shipments and revenue over the Alaska Railroad for 1957 through 1959 are given in Table VII-4.

The mainline of the Alaska Railroad is 483 miles long from Fairbanks to Seward and Whittier, with 54 miles of branch lines to coal fields and military bases. Increasing numbers of trailers, vans, and containers are being hauled on a "piggy-back" basis in the interest of improving service and reducing costs. However, as new highways are built these very cost savers for the railroad become more vulnerable to truck competition. Serious competition to the railroad from trucks and vans unloaded from barges at Valdez to run up the Richardson Highway to Fairbanks has been a factor for a number of years. A number of these truck-barge operations have failed, but as handling facilities improve and volume of freight increases the chances of success may improve. Average Alaska Railroad freight revenues are high, several times higher on a ton-mile basis than averages for railroads in the 48 states (5.5 to 6.5 cents as against about 1.5 cents), because of a number of factors – limited backhaul, extreme weather conditions, seasonal fluctuations, higher wage rates, and relatively low total freight tonnage.

TABLE VII-4. ALASKA RAILROAD, REVENUE FREIGHT TRAFFIC, BY COMMODITY GROUP AND BY AGENCY CLASSIFICATION, 1957-1959[(a)]

Category	1957			1958			1959[(b)]		
	Tons	Revenue	Revenue per Ton	Tons	Revenue	Revenue per Ton	Tons	Revenue	Revenue per Ton
TOTAL, ALL REVENUE FREIGHT	1,443,164	$12,417,550	$ 8.60	1,447,528	$11,268,254	$ 7.78	1,271,049	$11,219,073	$ 8.83
Total, Carload Freight	1,402,663	11,000,080	7.84	1,413,045	10,038,584	7.10	1,233,746	9,896,484	8.10
Products of Agriculture	5,137	83,973	16.35	3,982	66,349	16.66	2,468	39,113	15.80
Animals and Products	855	14,646	17.13	242	6,944	28.69	293	4,703	16.10
Products of Mines	748,979	2,433,953	3.25	855,268	2,835,893	3.32	682,382	2,172,912	3.15
Products of Forests	29,774	386,150	12.97	20,925	256,922	12.28	24,813	339,276	13.60
Manufactures and Miscellaneous	602,540	7,671,878	12.73	523,316	6,581,529	12.58	466,015	6,262,177	13.40
U. S. Army Class "A" Freight	15,378	409,480	26.63	9,312	290,947	31.24	57,775	1,078,304	18.80
Less-Than-Carload-Freight	40,501	1,417,470	35.00	34,483	1,229,670	35.66	37,303	1,322,588	35.30
Total, U. S. Army Carload Freight	748,694	4,139,307	5.53	820,085	4,200,224	5.12	n. a.	n. a.	--
U. S. Army Class "A" Freight	15,378	409,480	26.63	9,312	290,947	31.24	57,775	1,078,304	18.80
U. S. Army Petroleum Products	134,073	1,039,244	7.75	96,692	761,580	7.89	n. a.	n. a.	--
U. S. Army Coal	564,608	1,827,633	3.24	671,332	2,208,824	3.29	n. a.	n. a.	--
U. S. Army Other Freight	34,635	862,950	24.92	42,749	938,893	21.96	n. a.	n. a.	--
Other Government Agencies and Commercial Freight	694,470	8,278,243	11.92	627,443	7,068,030	11.26	n. a.	n. a.	--

Freight revenue per ton-mile in 1957, $0.05699; in 1958, $0.05652; in 1959, $0.06322.

(a) Source: "Alaska; Its Economy and Market Potential", U. S. Department of Commerce, Washington, D. C. (1959), p 24; 1959 data received from the Alaska Railroad.
(b) n. a. = not available.

As in the case of drastic reduction of tonnage when the Haines-Fairbanks military oil pipeline diverted $3. 5 million in revenue from the Alaska Railroad, other diversions contemplated or possible can be expected to work further reduction in the Alaska Railroad's freight income. For a railroad needing more, rather than less, tonnage to help reduce freight costs, pipelines and gas lines, distributing locally produced oil and gas as substitutes for coal, and improved highway facilities including the planned Anchorage-Fairbanks highway, constitute serious threats. While old products moving by new methods will cost users less than originally, other commodities that must still be moved by rail will have to cost more because they will carry a higher share of the total freight bill. When new products replace old products, such as gas replacing coal, the fuel user again enjoys a lower cost for heating or power generation, but freight costs on other commodities must go up. It is possible, however, that total costs will ultimately be lowered enough to provide increased buying power and industrial activity. It is questionable whether this could happen fast enough and smoothly enough to prevent serious revenue losses by the Alaska Railroad. Whether the railroad continues as a Government-owned facility or is taken over for operation by private interests or the State, it is sure to feel the impact of these impending transportation developments.

Local hauling firms, warehouses, water carriers, construction companies, and many other miscellaneous businesses and individuals have been dependent on the Alaska Railroad for supplies and services for many years. A number of these will find it necessary to relocate, change the pattern of their activities, or perhaps go out of business if rail rates go up or services are discontinued. Careful attention should be given to all possible "side reactions" and their impact on costs, incomes, and tax bases before irrevocable changes in the present rail-transportation pattern are made deliberately or encouraged inadvertently. However, the Alaska Railroad was built for development and defense; it has become a "humane" necessity to many isolated individuals and communities; it is not likely to be discontinued even though it became necessary to pay virtually all costs out of direct Government subsidy or unless it were a certainty that other communications lines would serve the people as effectively.

The White Pass and Yukon Route. The White Pass and Yukon Route comprises a narrow-gauge railroad and pipeline between Skagway, Alaska, and Whitehorse, Yukon Territory; served at the Skagway end by its 4,000-ton diesel-powered ship, the "Clifford J. Rogers", plying the Inland Passage to and from Vancouver, British Columbia, and served at the Whitehorse terminus by its trucking and bus system. Although much lower in tonnage than either the P. G. E. or the Northern Alberta Railways Company, it deserves second place in this discussion because of its closer proximity to Alaska and to the future development of both Alaska and Yukon Territory. The freighter ship service from Vancouver to Skagway covers a distance of 1,016 miles, and rail distance from Skagway to Whitehorse is 111 miles. The average combined freight revenue between Vancouver and Whitehorse of 2. 7 cents per ton mile(2) reflects the importance of the backhaul tonnage of asbestos fiber and ore concentrates and the low rates on those materials in the over-all rate-making picture.

The White Pass has worked out a number of innovations in its constant effort to fight rising operating costs. Special containers of various sizes that can be lifted from ship to flat cars at Skagway and then directly onto trucks at Whitehorse have reduced handling costs formerly encountered. These containers carry a variety of inbound commodities, and also outbound asbestos fiber from the Cassiar asbestos mine. The heavier zinc and lead-silver concentrates from United Keno mines are transferred from trucks to containers at Whitehorse for rail shipment to Skagway and thence by ship to Vancouver, and finally mainly to Trail, British Columbia by rail. Inbound shipments of groceries, equipment, appliances, and mine supplies run to about 85,000 tons, while outbound concentrates and asbestos total about 65,000 tons annually. Petroleum products (diesel and furnace oil) are shipped to Whitehorse by pipeline from Skagway and distributed by truck where needed in Yukon Territory. Gasoline, brought to Skagway by tanker, is transported to Whitehorse by tank car for ultimate truck distribution. As trucking routes have been developed, the White Pass has found river boats to be less and less vital to serving distant communities, so has abandoned these colorful relics of former glory. The White Pass management is giving consideration to the possibilities of minor rerouting to lower grades and of conversion from narrow to standard gauge. Without major capital expenditures, the management believes that the system could handle "three times as much tonnage", make reductions in tariff rates, and provide improved service, if this service were needed.

The future of the White Pass will require even more ingenuity and versatility by its operators in the coming years. The Stewart-Cassiar Road will provide a competitive alternative route for the present outbound tonnage, and much of the inbound. The Wenner-Gren (Pacific Northern Railway), should it reach its proposed destination in northwestern British Columbia and then extend into Yukon Territory, could further reduce the already limited freight available to the White Pass. However, if either of these planned transportation additions should stimulate significant industrial and economic development in Yukon Territory, the White Pass could see a resurgence of its opportunities far surpassing anything it has known before.

Pacific Great Eastern Railway. The P. G. E. has had an interesting career that took a dramatic turn in 1956 when the original line was extended at the southern end from Squamish to North Vancouver. Even more dramatic was the extension, finished in late 1958, at the northern end from Prince George to Fort St. John and Dawson Creek, British Columbia. There are now 789 miles of main line, plus 126 miles of yard track and sidings, and 23 miles of industrial track. Average 1959 freight haul was 217 miles with revenue per ton mile of 3.4 cents.

During the period from 1954 to 1960, tonnage increased from some 880,000 tons to over 1.5 million tons. Prior to that period, net tons handled at 5-year intervals were a follows: 1943 – 131,000; 1948 – 229,000, and 1953 – 605,000. Major items of freight hauled included the following, shown as percentages of the total:

	1943	1948	1953	1959
Agricultural Products	12.0	10.0	1.5	3.4
Forest Products	69.0	54.0	80.0	78.0
Manufacturing and Miscellaneous	14.0	31.0	15.0	13.0
Mines				3.4
Less Carload	5.0	5.0	3.5	1.1

Examination of British Columbian exports suggests that a fair proportion of agricultural and forest products shipped over the P. G. E. may depend on foreign destinations, also.

The P. G. E. traverses rugged country that would be slow in development without freight service of some kind. Although the heavy dependence on forest products has continued since the line was extended, it is reasonable to expect that this pattern will change as minerals (including oil) exploration and development go forward. Gradually, more and more partial processing and refining of some of the developed minerals, as well as forest and agricultural products should become economically justified.

Northern Alberta Railways Company. The Northern Alberta Railways system operates in northwestern Alberta (Figure VII-1). Two N. A. R. lines run from Edmonton - one to Waterways and the other to Dawson Creek via Grande Prairie. In December, 1958, the first interchange of freight was made at Dawson Creek between the N. A. R. and the P. G. E. The pattern of Northern Alberta Railway shipments in 1958 and 1959 was as follows:

	N. A. R. Shipments, 000 tons					
	Originating on N. A. R.		Received From Other Roads		Total Carried	
	1957	1958	1957	1958	1957	1958
Agricultural Products	632	554	16	16	648	570
Animal Products	22	22	1	1	23	23
Mine Products	43	49	90	89	133	138
Forest Products	340	289	20	12	360	301
Manufacturers and Miscellaneous	24	16	373	276	397	292
Less Carload	5	4	21	17	26	21
Total	1,066	934	521	411	1,587	1,345

This railroad finds itself vulnerable to economic activity of its two major sources of freight and to competition from trucking concerns. All railroads are subject to the same pressures, but these are especially strong in the case of a railroad that serves a new area far from markets, that must rely on a limited number of products, and that blazes trails for new highway development. Ultimately, of course, a balance can be struck between the several modes of transportation, each getting its appropriate share of freight traffic. The economic and industrial development that new transportation facilities foster can mean a decided increase in total freight to be carried. Opening of the iron deposits at Hines Creek (served by the Grimshaw spur of the N. A. R.) would boost freight over this line considerably.

Highways and Trucking. Highways and lesser roads in Northwest North America are for the most part local as far as the freight function they perform is concerned.

Within Alaska, major highways such as the Glenn, Richardson, Tok, Haines, and Alaska serve primarily to move commodities landed at Seward, Anchorage, Haines, and Valdez to Fairbanks and other interior consuming points. Table VII-5 briefly describes the major Alaskan highways; their location is shown on Figure VII-1. In addition, they permit residents of this "Central Alaska" area to "move around a little" and, of course, these highways are vital communication links among the various military-defense installations near Anchorage, Fairbanks, and Big Delta. The only other area of significant population in Alaska - Southeastern Alaska - does not enjoy such freedom of movement by land, or any other low-cost, individual way of seeing the contiguous areas.

TABLE VII-5. MAJOR ALASKAN HIGHWAYS[a]

Highway	Places Connected	Months Open	Distance, miles
Alaska	Dawson Creek, British Columbia, and Big Delta Junction, Alaska, merging with Richardson Highway thence to Fairbanks	All year	1,523
Copper River (under construction)	Cordova and Willow Creek, joining Richardson Highway (39 mi.); and Cordova and Cordova Airport (13 mi.)[b]	All year from Willow Creek to Chitina (Edgerton Highway), and from Cordova to airport	170
Denali	Mount McKinley National Park and Paxson, joining Richardson Highway	June-September	160
Elliott	Fairbanks and Livengood	May-November	76
Fairbanks-Nome (under construction)	Fairbanks-Livengood-Eureka	May-November	150
Glenn	Anchorage-Palmer-Matanuska Valley-Glennallen	All year	189
Haines	Haines, Alaska, and Haines Junction, Yukon Territory, joining Alaska Highway	All year to Canadian border; May-November to Alaska Highway	154
Richardson	Fairbanks and Valdez	All year	365
Seward-Anchorage	Seward and Anchorage	All year	131
Steese	Fairbanks and Circle	May-November	164
Sterling	Kenai and Homer, also connecting with Seward-Anchorage Highway	All year	150
Taylor	Tetlin Junction (on Alaska Highway) and Eagle	June-November	161
Tok	Tok Junction (on Alaska Highway) and Gulkana (on Richardson Highway)	All year	120

(a) Source: "Alaska, Its Economy and Market Potential", U. S. Department of Commerce (1959).
(b) Completed in 1958 as far as Mile 49 (Million Dollar Bridge).

In British Columbia, northwestern Alberta, and Yukon Territory, the Hart and Prince Rupert Highways (British Columbia), Mackenzie Road (Alberta), and the Alaska Highway and Mayo Road (northeastern British Columbia and Yukon Territory) permit much movement of supplies, equipment, and mineral, agricultural, and forest products into and out of the region either on a long-haul basis, or via rail-highway junctions. Stretches of the Alaska Highway, particularly in the Yukon, facilitate local trucking centered on Whitehorse.

To a limited extent, the combination of British Columbia's Cariboo and Hart Highways and the Alaska Highway permit movement of travelers and freight between Seattle-Vancouver and Fairbanks. To an even lesser extent, freight and passengers travel to Fairbanks over the Alaska Highway en route from mid-West U. S. and Canadian starting points. The condition of some of these highways, notably the Alaska Highway's gravel, seasonally dusty surface (Canadian portion) discourages tourists, but has little deterring effect on truckers. Representatives of the trucking industry in Northwest North America have expressed a strong preference for the all-weather and heavy load-bearing characteristics of the gravel surfaced road – mainly on the assumption that long stretches involved might receive inadequate snow removal and sanding during winter months and punitive overloading taxes if the highways were paved.

All major highways in Alaska are paved, although in many sections they are anything but smooth, due to annual freezing and thawing. The American highway departments tend to be under considerable pressure by the citizenry to construct paved roads. Conversely, Canadians appear more willing to build all-weather gravel roads, especially in underdeveloped areas, on the theory that they can thus build more miles of road at lower cost and that such roads are better suited to trucking – the initially, most important use of new roads.[3]

As previously mentioned, the quantity of freight trucked over the Alaska Highway from the 48 states to Alaska is small (13,000 tons or less per year). Over short sections of this highway, in British Columbia and Yukon Territory especially, higher tonnages (in excess of 100,000 tons – petroleum products, zinc and lead concentrates, and asbestos fiber) are trucked. Trucking rates of 7 to 11 cents per ton mile on most commodities that might be shipped from the 48 states limit the use of this method of transportation to perishables and a restricted number of high-value items. Motor-trucking costs under 5 cents per ton mile (figured on a one-way haul basis) on gravel roads can be attained by heavy haul methods, such as those being used by Cassiar Asbestos in British Columbia, and United Keno Hill mine in Yukon Territory.[4]

Air Transportation

For many locations in Northwest North America, contact with the outside world would be a rare and tedious affair were it not for the airplane. Coastal towns would depend on occasional visits by commercial and private vessels; interior towns would look for the seasonal appearance of riverboats or dogsleds. Certificated airlines serving Alaska are shown in Figure VII-5.

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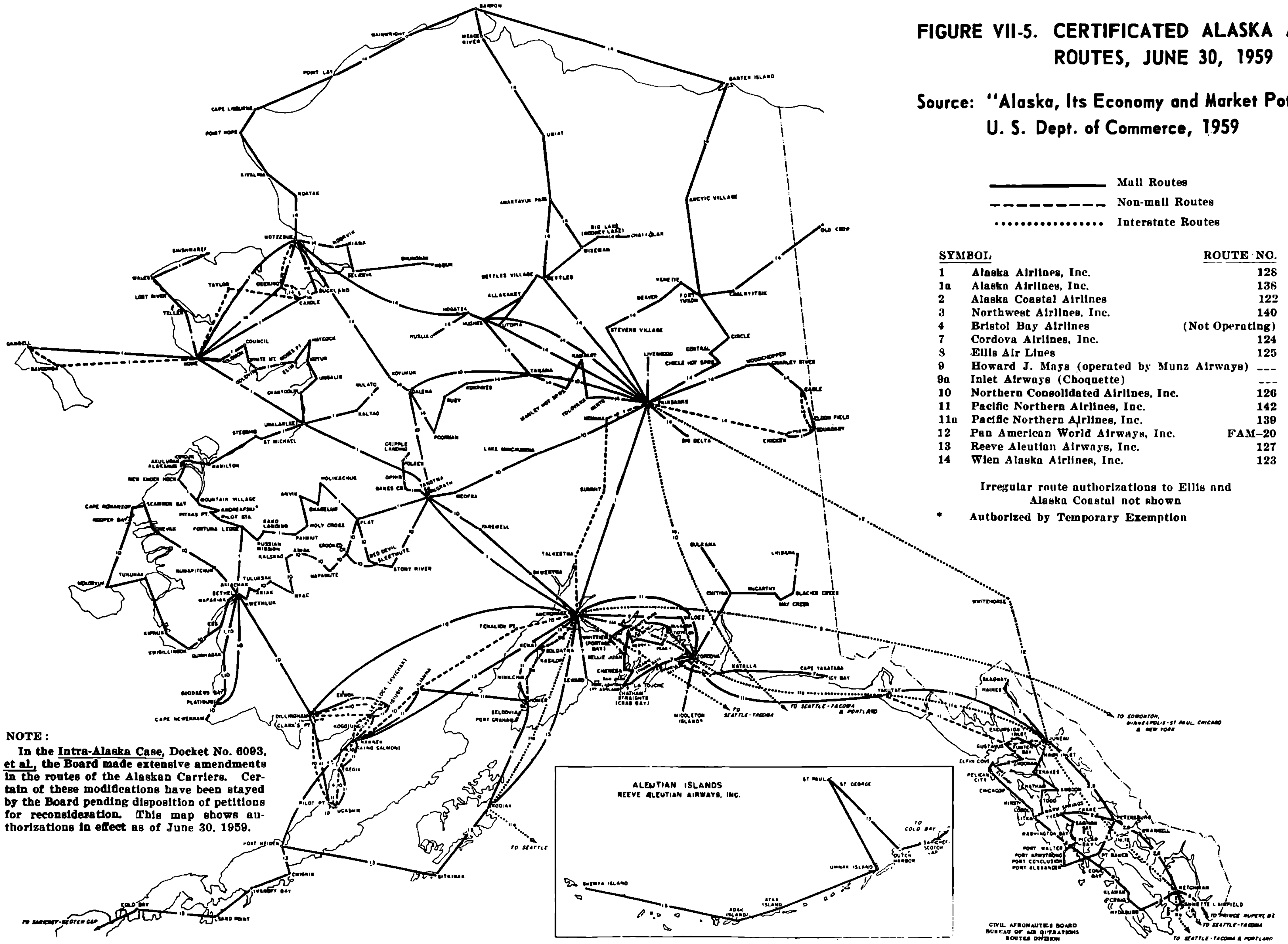
FIGURE VII-5. CERTIFICATED ALASKA AIR ROUTES, JUNE 30, 1959

Source: "Alaska, Its Economy and Market Potential" U. S. Dept. of Commerce, 1959



Mail Routes (solid line)
Non-mail Routes (dashed line)
Interstate Routes (dotted line)

SYMBOL		ROUTE NO.
1	Alaska Airlines, Inc.	128
1a	Alaska Airlines, Inc.	138
2	Alaska Coastal Airlines	122
3	Northwest Airlines, Inc.	140
4	Bristol Bay Airlines	(Not Operating)
7	Cordova Airlines, Inc.	124
8	Ellis Air Lines	125
9	Howard J. Mays (operated by Munz Airways)	---
9a	Inlet Airways (Choquette)	---
10	Northern Consolidated Airlines, Inc.	126
11	Pacific Northern Airlines, Inc.	142
11a	Pacific Northern Airlines, Inc.	139
12	Pan American World Airways, Inc.	FAM-20
13	Reeve Aleutian Airways, Inc.	127
14	Wien Alaska Airlines, Inc.	123

Irregular route authorizations to Ellis and Alaska Coastal not shown

* Authorized by Temporary Exemption

NOTE:

In the Intra-Alaska Case, Docket No. 6093, et al., the Board made extensive amendments in the routes of the Alaskan Carriers. Certain of these modifications have been stayed by the Board pending disposition of petitions for reconsideration. This map shows authorizations in effect as of June 30, 1959.

There are eight intrastate scheduled airlines and numerous certified common carriers, contract carriers, and private individual or company planes used in transporting supplies and in exploration and development of oil and mineral resources. In addition, there is one private airplane for approximately every 165 Alaskans. Plane service to eastern Canada and the other 48 states via Edmonton and Vancouver or Seattle and Portland is maintained by four U. S. airlines or by connection with Alaskan airlines on a daily or semiweekly basis. Several European lines include stops at Anchorage or Fairbanks en route from Europe to the Orient. Jet service will shorten travel time to and from Alaska in the near future.

Passenger travel, plus mail and other forms of Federal subsidy, make cargo carrying by air a reasonably profitable business. Even so, inbound shipments by air have been limited to 8,000 to 10,000 tons in recent years because of the scarcity of return freight loads – the ever present limiting factor for all forms of transportation serving Northwest North America.

Planned Facilities

In spite of the fact that markets in Northwest North America limit tonnage to be shipped into the Area, and that production in the Area provides relatively small quantities of backhaul tonnage for all forms of transportation, a number of "planned"* additions or improvements to the transportation system are being considered. With a few exceptions, most of these planned facilities center around the expectation or hope that they will increase personal travel sufficiently to justify the improvement. It is further reasoned, in the case of some of the plans under consideration, that new facilities will stimulate resource and industrial development, rapidly enough, it is hoped, to reduce initial subsidies substantially or to pay off revenue bonds. Appealing arguments are advanced that each new facility will decrease costs and increase volume of imports, improve the competitive position of producers in Northwest North America in world markets, and stimulate economic growth throughout the Area.

For Alaska, the state and federal agencies are working strenuously to satisfy as many as possible of the requests for new transportation facilities received from each community. Extensions of existing roads, and new roads being planned by Alaska's Department of Public Works are shown in Figure VII-1. The majority of requests, of course, are for roads, preferably paved highways. Where roads are impossible, as in the case of connecting Southeastern Alaskan cities, a ferry service is being planned.

In Canada, provincial and dominion governments are concentrating on "access" and "resources development" roads, with limited consideration being given to paving existing and new roads. New "territorial" roads connecting Watson Lake and Ross River, and Dawson and Fort McPherson in Yukon and Northwest Territories are going forward. In addition, numerous "proposed" roads and railroad extensions are being considered, particularly in British Columbia.(6)

* To a considerable extent, it is difficult to distinguish between a "plan" and a strong "desire" or "proposal"; which some of these will be can depend a great deal on the funds made available and the political pressures applied.

Airport improvements, new or improved harbor facilities, and innovations in waterborne transportation methods are all receiving attention from governmental agencies or private companies.

Water Transportation

The most sought-after improvement in water transportation for Alaska is the Southeastern Alaska ferry serving that area from Prince Rupert. Several versions of the idea have been presented in detail.[5] The comprehensive Toner report, including and appraising earlier studies made of the subject, endorses the "fast ferry" concept. This concept, originally proposed by W. C. Gilman and Company of New York City, and endorsed or modified by Felix J. Toner, Juneau, Alaska, provides the following:

Route	Prince Rupert — Ketchikan — Wrangell — Petersburg — Juneau — Haines — Skagway
Total Time	26 hr
Capacity per Vessel	100 automobiles; 500 passengers
Number of Vessels and Vessel Speed	Three, 18 knots
Costs	
Vessels (Three)	$11,325,600
Terminals (Eight)	2,881,000
Parts, Materials, Services	500,000
	14,706,600
Financing	1,793,400
Total (Bond Issue Required)	$16,500,000

Various methods of financing and ownership have been proposed and given consideration by consultants and the several governmental agencies involved.

There seems to be little doubt that some form of ferry service will be set up to provide daily, year-round travel for passengers and automobiles from Prince Rupert to Southeastern Alaskan towns and possibly to other towns in Central Alaska. Some freight may also be hauled by such a ferry, probably only that which can be carried in trucks, containers, and vans. The greatest emphasis, however, is being placed on tourist travel.

The urgent need for the ferry is obvious for it would provide present residents of Southeastern Alaska with a cheaper service than now exists for travel within and outside the area and might serve to make life in the region more attractive to outsiders contemplating a move into the region. Movement of higher class freight and mail should be speeded up. Finally, such service should exert an important influence toward greatly expanded travel by tourists, both into Southeastern Alaska and beyond into the Yukon and Central Alaska. For purposes of this report the service is considered a "planned" facility.

In view of the steps also being taken by several contract and common carriers to increase freight service by rail-barge, container-barge and van-barge from Prince Rupert and Seattle or Portland to Southeastern and Central Alaska ports, it is probable that these will carry most of the freight volume in these waters. Trucks using the ferry would most likely be those carrying commodities requiring speedy delivery.

British Columbia highway officials have serious plans on paper for extension of the Island Highway on Vancouver Island to Port Hardy; installation of ferry facilities from there to Kitimat; use of the present road from Kitimat to Terrace; and possible construction of a new road through Aiyansh to the Stewart-Cassiar road. Such a through system would add another alternative route for auto travelers and truckers to Northwest North America from the Puget Sound area.

The White Pass and Yukon is giving some consideration to the merits of converting its line from narrow to standard gauge. If this were to be done it would permit extension of the present rail-barge service now operating from Tacoma and Prince Rupert to Ketchikan and Sitka, on to Skagway where the cars could be moved up the White Pass route to Whitehorse, Yukon Territory. Ultimately, a railroad could be built northwest from Whitehorse all the way to Fairbanks, should enough tonnage be developed to justify such construction.

Very fast waterborne service is being advocated by some interests who see in the hydrofoil ship, capable of speeds up to 40 to 60 miles per hour, the ideal vessel for fast passenger and freight service between the Pacific Northwest and Alaska. The first hydrofoil ship, carrying up to 60 passengers, to go into service in the area was to have its inaugural trip early in August, 1960, between Bellingham, Washington, and Victoria, B. C. The operators of this service foresee use of similar vessels in the Alaska trade.

All water carriers now in active service in the Alaska trade are making strenuous efforts to adopt or devise new methods of handling freight more efficiently and economically. Containerization, "fishy back", self-unloading devices, and numerous other innovations are being installed or tested. Serious consideration is being given to the possible use of insulated tankers to carry liquefied natural gas from Alaska to Japan and possibly to West Coast, U. S. ports, Hawaii, and other Pacific destinations.

Although few of the innovations mentioned in a Wall Street Journal article in 1956* have been alluded to in plans associated with Northwest North America, several may assume importance at some future date. For instance, although it probably would not apply to existing dissolving pulp mills, future paper pulp mills may find it appropriate to ship wet "noodle" pulp in specially designed tankers as Crown Zellerbach is now doing from its pulp mill on Vancouver Island to its Kraft paper plant at Antioch, California.

* Wall Street Journal, February 16, 1956, page 1, reproduced at the end of this section.

Rail Facilities

Very serious plans to build two new rail lines in Northwest North America are under way. These are the Wenner-Gren (now spoken of as the Pacific Northern Railway) project in northern British Columbia, and the Pine Point Railway in northern Alberta, both shown on the accompanying map, Figure VII-1. Each of these has been the subject of great controversy and speculation, including some frankly expressed doubts that they will ever be carried through to completion.

The Pacific Northern Railway is planned to extend from the vicinity of Summit Lake near Prince George, B. C., to the Yukon border in the vicinity of Gladys Lake, and would be 697 miles long. As the first few hundred miles would be through rich forest country the railroad is expected to derive most of its initial revenue in hauling logs and pulpwood to existing pulp and lumber mills in central British Columbia. As it extends its length further and further northwest, perhaps at the rate of 100 miles per year or as its business justifies*, it is hoped by backers of the railroad that pulp and lumber mills may be built adjacent to it; also, it is hoped that mineral developments will take place that will provide the heavy tonnage such a railroad must have to operate at a profit. Plans to study costs of extending this line on across Yukon Territory via Carmacks and Selkirk, thence westward via the Yukon, White, and Ladue Rivers to the Yukon-Alaska border (aimed at joining the Alaska Highway route near Tetlin Junction) were announced in July, 1960. This is discussed in more detail in Chapter VIII of this report.

The Great Slave Lake Railway routes were studied by the Canadian Federal and Provincial Governments, local interests, and the railroads backing such a project – the Canadian National and Canadian Pacific. The primary purpose of such a railroad would be to haul zinc and lead concentrates from Consolidated Mining and Smelting Company's deposits on the south shore of Great Slave Lake. The two routes under consideration would run from: (1) Grimshaw, Alberta, to Pine Point, N. W. Territories, and (2) Waterways, Alberta to Pine Point. Each route has its strong proponents, although either route would satisfy the main purpose of bringing lead-zinc concentrates to the Cominco smelter at Trail, B. C. Either route can connect with rail routes to tidewater at Vancouver, should that be desirable for any reason. The westward route would run through the area considered in this study, but would have no relationship whatsoever with a linkage between Alaska and the southern 48 states. In June, 1960, the 3-man Royal Commission studying the routing problem reported divided opinions, and it was decided late in 1960 to use the western route and make a detailed survey of it.

Highways

Throughout Northwest North America highway plans and counter plans are preoccupying the attention of highway engineers, politicians, chambers of commerce, federal agencies, and residents of Alaska, British Columbia, Alberta, Yukon and Northwest Territories. Each has a strong case, if one leaves out the factor of "economic justification". Ironically, economic justification is hard to establish. Northwest North America is unfortunately "blessed" with a very large amount of difficult terrain that makes road-building costly, and the palliative of a few miles of road building a year, as economics might "justify", is difficult to take if one is out there many miles from the road at the end of what seems to be "nowhere". "Take all the isolated communities and connect them with each other by roads, and people will be willing to take a chance on moving in",

* Authorities associated with this project are divided in opinion as to the basis for extension; some believe in extension at a steady rate per year, others on more of a "build and wait for developments" principle.

say the Alaskans, desperately anxious to refute the economic "chicken and egg" dilemma. It may well be they have a point, and state, provincial, and federal governments are trying to find out.

Figure VII-1 shows the "planned highways" in Northwest North America. These are included in "5-year plans" at state, provincial, and federal levels. The measure of action is the apportioning out of available or potentially available funds; priority is determined on other grounds.

All highway building programs for Alaska are set up in an effort to satisfy the wants of individual communities there, and some may have a significant effect on resource development, particularly minerals and agricultural products. Other resources, such as fish and forest products, seem not to depend on new roads to any appreciable extent, except for logging roads in the case of the latter. Tourism, however, comes to the rescue in providing the needed stimulus. The planned road out of Petersburg toward British Columbia appears to coincide with Canadian programs, and has, in addition to providing an "escape hatch" for a small segment of Alaska, the possibility of providing access to tidewater for such minerals as may be developed along its route to a junction with the Cassiar-Stewart Road. Other elements of Alaska's 5-year program comprise: (1) a highway between Anchorage and Fairbanks, (2) continuation of work on the Copper River highway and Bering River Road, and (3) reconstruction of present roads, bridges, freeways, and other improvements in presently populated areas.

The Cassiar-Stewart Road being built by the B. C. Highway Department is expected by that Department to provide a lower-cost route for transportation of Cassiar's asbestos fiber than is now applicable via the White Pass and Yukon Route. When the Cassiar-Stewart Road is completed and if the Pacific Northern Railway is built through virtually the same country, one must wonder how all three (including the White Pass Route and to some extent the Alaska Highway and the Southeastern Alaska ferry) are going to survive on the limited tonnage that must be shared among them. However, it is expected that the Cassiar-Stewart Road would provide easier access to potentially promising mineralized areas for exploration and exploitation. Also, once built, it will provide an enticing segment for a shorter route from Prince George to Fairbanks, via Hazelton, Dease Lake, and Atlin, and provide for connections with coastal towns in Southeastern Alaska.

In the Yukon and Northwest Territories, the Canadian Government is pushing programs to open up the country and to provide access roads to mineral operations already in progress. The latter seem to be particularly justified by the fact that companies have started these mineral operations on the basis of overland freight hauling over trails or via airplane. Roads that provide faster, more economical transit should encourage more rapid development of other deposits in the vicinity, and spur additional exploration activities. Roads that go into promising and yet undeveloped regions should spur new exploration activities; the Alaska Highway is one of Canada's best examples of what new roads will do in this regard. So more and better roads ranging out north and west from Watson Lake to Ross River, and north from Dawson, Yukon Territory to Fort McPherson, Northwest Territories, intrigue the Canadians* with the potential of these roads for spurring development of these regions. Generally speaking, the Canadians would rather have more miles of gravel roads than fewer miles of paved roads.

* From data in Jenness' paper[see Ref. (3)] and personal discussions with Jenness, Erik Nielsen (M.P., Yukon Territory) and others in British Columbia and Ottawa.

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Some revolutionary modes of transportation are being considered, such as various designs of cross-country equipment. For example, further application of the LeTourneau diesel-electric individual wheel drive truck train may be expected for overland transport, but the economics are yet to be proved. One contract carrier went bankrupt, it is alleged, because costs were underestimated and problems were excessive.

Air-Transportation Improvements

The airlines are working on plans to provide jet service in Alaska along with their programs for jets in the southern 48 states. The problems of extending existing air-strips have arisen but it may be assumed that these will be resolved completely now that initial steps to lengthen strips have been taken at Fairbanks and Anchorage. Also, as international airlines find it profitable to do so, they apply for permission to land at Alaskan airports en route between Europe and the Orient and request stop-over privileges.

Major airlines are conducting tests on radically new designs that they hope will provide reductions in air-freight costs anywhere in the world. Should they be as successful as some spokesmen anticipate, air freight will cost only 4 cents per ton mile. The impact of such a development on railroads, truckers, and even some water carriers might be quite significant. On the other hand, just as all carriers have found, especially in Northwest North America, one-way hauls demand high rates. Air carriers, too, require full payloads both ways on regular schedules to provide any such low rates.

Summary

On the basis of tonnages hauled, the Alaska Steamship Company's 500,000 tons and the Alaska Railroad's 1,500,000 tons make these two the outstanding freight transportation media serving Alaska. Most of Alaska Steam's freight is landed at Seward and travels over the Alaska Railroad's line to Anchorage and Fairbanks, with the remainder going via Valdez and the Garrison Fast Freight trucks to Fairbanks and other interior points. Moderate tonnages (85,000 tons inbound and 65,000 tons outbound) move over the White Pass and Yukon Route involving a water shipment between Vancouver and Skagway, rail carry between Skagway and Whitehorse, and truck shipment to points beyond in Yukon Territory and British Columbia. Southeastern Alaska is served by contract carriers, in addition to the relatively small amounts of general cargo tonnage carried by Alaska Steam; notably these are rail-barge operations bringing raw materials to the two new pulp plants operated at Ketchikan and Sitka and moving out pulp from these plants and lumber from sawmills at Wrangell. The Ketchikan Merchants Charter Association has been operating several 150-ton boats between Southeastern Alaskan ports and Seattle and Prince Rupert for the past several years. The movements of rafted or barged logs among the Southeastern Alaskan cities, often reported in port tonnage figures, are not relevant to this discussion. Finally, the movement of cannery supplies to Alaskan ports and the export of canned salmon from these points mainly to Seattle and Portland, are handled by Alaska Steam and contract carriers on a highly seasonal basis. For the most part, existing transportation patterns are primarily on an inbound haulage basis.

In addition to the major tonnages moved to Alaska by water and thence by rail or truck to principal consuming centers – Anchorage and Fairbanks – some tonnage has moved by truck (less than 13,000 tons annually since 1950) over the Alaska Highway and some by air freight (9,000 tons of cargo, 3,000 tons of mail, maximum, annually in the period 1950-1959). Likely choice of shipping method may be discerned from a quick perusal of shipping costs from Pacific States to Alaska by the three routes, bearing in mind that speed of service and perishability of the commodity usually dictate preference for a higher cost routing. Air freight to Anchorage (1 day) averages $17 to $20 per 100 pounds; trucking costs range from $6.50 to $9.50 per 100 pounds with shipping time of approximately 5 days; and costs for water shipment (7 days) run between $2.50 and $7.50 per 100 pounds.

Passenger movements to and from Alaska are predominantly by air (about 60 per cent), followed by highway (slightly less than 33 per cent), and by water (approximately 7 per cent). Both air and highway travel have increased their share of the total at the expense of water passengers over the past decade. This subject is treated in considerable detail in the "Tourism" section of Chapter V.

Examination of past and present developments of resources and modes of transportation associated with them has revealed little evidence that development of major resources has suffered directly from a lack of transportation facilities or from unreasonable freight rates. Production of gold, copper, mercury, fish, and forest products, for example, has been carried out to the extent raw materials were available and adequate demand existed. In major population centers – Anchorage and Fairbanks – construction (primarily military), trade, services, and governmental agencies, all paying high wages, have taken care of (and contributed to) high transportation costs and cost of living. However, as has been shown in the section on agriculture, for example, development of some products may have suffered from inadequate transportation facilities to provide wider distribution in local markets and from high costs on machinery, fertilizers, and other farm needs. Thus, transportation has been at least one factor in slow agricultural development. A number of other factors such as climate, soil conditions, markets, etc., have been shown to be very strong contributors to this slow development.

Over the years, river boats on the principal navigable rivers of Alaska, Yukon and Northwest Territories, and British Columbia have carried, and still do to a limited extent, passengers and freight where no other mode of travel was available. Of course, these freight avenues are open only a few ice-and-flood-free months of the year. Alternative methods have been developed for winter freighting when the rivers are not navigable; in some cases, combinations of river movement to staging points and tractor-train or truck haulage on into the interior after the freeze-up have proved highly effective. Since overland heavy hauls can mire down if they start too soon in the fall or too late in the spring, careful planning is essential for top economy.

Transportation improvements in speed, convenience, and/or costs might have changed the pattern of Alaskan economic development somewhat in the past. The fates of almost a hundred water transportation companies that had a short-lived activity over a period of years in serving Alaska sound a fairly loud warning that limited, predominantly one-way, heavily seasonal tonnages make a poor basis for extensive competitive operations. New transportation arteries that have taken over a sizable share of the total existing business may temporarily damage or permanently destroy established operations. Some of the "planned" or "developing" transportation changes might do so again. When a new operation finally proves to be uneconomic, the damage may already have been done. The older displaced operator may be unable or unwilling to return. Then, freight costs rise and service is poor. All these things have happened in Alaska before; they can happen again! Proper planning and realistic thinking and action on the part of all concerned can prevent or minimize trouble.

Planned transportation facilities should contribute importantly to satisfying desires for alternative routes for shipments of raw materials, food, equipment, etc. and for local and visiting persons' business and pleasure travel. The Stewart-Cassiar road and possible Pacific Northern Railway in British Columbia, marine ferry service to ports in Southeastern Alaska, new dock facilities at Anchorage, "development roads" in Yukon Territory, and a variety of van-barge and rail-barge operations from Seattle, Portland, and Prince Rupert to major Alaskan ports – all give promise of fulfilling some of these desires and of ultimately reducing shipping costs and stimulating economic development in Alaska, British Columbia, and Yukon Territory.

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From Wall Street Journal, p 1, February 16, 1956.

VERSATILE VESSELS

Ships Tackle New Jobs, Handle Cargo Faster And More Efficiently

Tankers Tote Orange Juice, Beer; "Noodle" Ship Ends Paper Producer's Problem

Flat Tops for Two Tankers

BY MITCHELL GORDON
Staff Reporter of THE WALL STREET JOURNAL

NEW YORK - The world's seagoing freighters are acquiring a new versatility.

Ships are tackling a wide variety of new jobs. They're handling both old and new tasks with greater speed and efficiency. These steps are bolstering profits of shipping lines and cutting costs for both shippers and consumers.

Pan Atlantic Steamship Corp. today will announce the launching of the world's longest-haul seagoing truck-trailer service. The Waterman Steamship Corp. subsidiary this spring will start using two specially-fitted oil tankers to tote trailers between Newark, N. J., and Gulf Coast ports. Each tanker is topped with a flat deck, which looks something like an aircraft carrier's flight deck. This deck holds 58 trailers.

Fresh Orange Juice

Late next month, the S.S. Tropicana is scheduled to steam up New York's East River and nose into a new terminal at Whitestone, Queens. Swishing around in its innards - vacuum-packed in huge stainless steel containers - will be enough fresh orange juice to fill a glass for each man, woman, and child in New York City. The world's first orange juice ship will be completing its maiden voyage from Florida.

Plying between British Columbia and Alaska is the recently-launched Clifford J. Rogers, a ship equipped to handle such widely-varied cargo as fertilizer, crated generators, mineral rock and refrigerated foods. In its holds are 168 steel cargo containers - each seven feet high, eight feet wide and eight feet long. In port, the containers can be yanked out by cranes and deposited directly on railway flat cars or truck trailers. The ship then can be re-loaded with pre-packed containers and within hours be on its way again.

With its growing versatility, the world's seagoing fleet is cutting down the losses in time and money that result when a ship must run empty from one port to another.

Flat-Topped Tankers

Pan Atlantic's flat-topped tankers at first will haul trailers both ways on the Newark-Gulf Coast run. The company later will supplement the tankers with specially-built trailer ships. The tankers then would concentrate on carrying oil to Newark and trailers to Gulf ports.

Under construction in Japan is an 83,000-ton combination oil and ore ship, which will rank as the world's biggest cargo carrier. The monster is being built by New York's National Bulk Carriers, Inc., for one of its subsidiaries, Universe Tankships, Inc.

Already in service is another ore-oil carrier, the 55,000-ton Petrolore. Built by National Bulk, the Petrolore has been leased to Sinclair Oil Co.

A little over a year ago, Ore Transport, Inc., owned by American-Hawaiian Steamship Co. and five steel concerns, converted four freighters to haul either oil or ore. From April to November, these ships tote iron ore from Seven Islands, Quebec, to Philadelphia. In the winter, the ships are offered for short-term charter as oil tankers.

Climbing costs impel ship operators to avoid idle - or empty - vessels. Ship construction costs, for example, have jumped about 400% in the past 20 years. Cargo handling costs are up sharply, too.

Beating the Competition

Even so, new types of vessels often offer savings over rail and truck competitors. For example, Anthony Rossi, head of Bradentown, Fla.'s Fruit Industries, Inc., figures he'll be able to ship 1.5 million gallons of fresh orange juice to New York in the S.S. Tropicana for only $15,000, compared with over $250,000 for current truck shipments.

When the Tropicana is in full operation, Mr. Rossi hopes the freight savings will make it possible to cut by as much as four cents a carton the present 29-cent retail price of fresh orange juice in New York. The Tropicana is operated by New York's Prudential Steamship Corp.

Orange juice isn't the only beverage now showing up in ships' tanks. Chugging through Holland's waterways is the Gerritje, a tanker launched last October. The Gerritje hauls Heiniken beer, a popular brew in the U. S. as well as in Europe, from yeast cellars in Rotterdam to lagering (aging) cellars and a bottling plant in Bois-le-Duc, just 50 miles away.

The brewer, Heiniken's Bierbrouwerij Maatschappij N. V., figures the beer tanker will haul close to 16 million gallons of the golden beverage each year, at a saving of "at least 50%" of the cost by rail tank car. The company figures the beer will be better, too. It gets a much smoother ride by ship than it would by rail or truck, an official explains.

Tanks of Wine

Another beverage-toting vessel is the Norwegian steamship, the S/K Lysaker. The Lysaker plies between France and North Africa with its specially-equipped tanks full of bulk wine.

Universe Tankships this summer will put into service for San Francisco's Crown Zellerbach Corp. another new type of ship. The new 560-foot-long vessel will haul pulp in its wet or "noodle" form from the big paper company's Elk Falls mill on Vancouver Island, British Columbia, to its new kraft paper plant at Antioch, Calif., some 1,000 miles to the south.

Pulp now is shipped dry from the mill to the paper plant and then returned to its wet form. The re-wetting process is not only costly and time-consuming but also may impair the quality of the paper.

The new ship will use a six-foot-wide conveyor belt to drop the wet pulp noodles into the holds and mechanical spreaders to distribute them inside. The noodles will be flushed out at Antioch with hydraulic pumps.

Dow is Enthusiastic

An enthusiast for sea transport is Dow Chemical Co., which in 1949 switched part of its rail tank car shipments of chemicals to a newly-converted tanker. A second chemical carrier, specially built for the job, now busily feeds Dow's East Coast plants with chemicals from the company's Freeport, Texas, installation. The two vessels, the Marine Chemist and Marine Dow-Chem, are operated for Dow by New York's Marine Transport Lines, Inc.

Warren Petroleum Co. of Tulsa took delivery last month on the last of an initial six-vessel fleet designed to carry gas in liquefied form in tanks of 10,000-to-30,000-gallon capacity. The gas, propane, is used in homes where pipeline gas is unavailable and for certain industrial purposes. One of these vessels, the Metali O. Warren, brings some 1.2 million gallons of gas from Houston to Newark each two weeks. Says a Warren official: "It does the work of 1,250 railroad tank cars and makes the round trip in about half the time".

Another new ship, its 10,000-gallon tanks bereft of bronze and brass fittings as a precaution against contamination, will be coming off the ways of the Jakobson Shipyard, Inc., at Oyster Bay, Long Island, next month. Later, it will set its course for a month-long voyage across the Atlantic to join the latex-hauling fleet of Farrell Lines, Inc., in Liberia. These ships, of which the new vessel will be the largest, chug 35 miles up the Marshall River to the rubber plantations of Firestone Tire & Rubber Co. at Harbel to pick up rubbery fluid which later will be transferred to the deep tanks of bigger U. S.-bound Farrell Line ships.

Two big ships turned over to the Royal Dutch Shell Group by the Deutsche Werft in Hamburg within the past 18 months carry hot asphalt, kept at 285 degrees Fahrenheit, from petroleum plants in the Caribbean and elsewhere to roadbuilding centers of the world. A vessel operated by Michigan Atlantic Corp. of New York since the end of World War II carries as much as 1,000 tons of coconut oil at a time between Baltimore and Boston.

Self-Unloading Ships

Facilitating the unloading of dry cargo carriers is wider use of self-unloading equipment. In recent years, for example, U. S. Gypsum Co. has built two 10,000 tonners with self-unloading facilities; it's putting a third in service this spring and a fourth at the end of the year. The new vessels will be capable of unloading themselves almost anywhere in just ten hours, practically at the push of a button. Many ports lack facilities to handle ships which have no self-unloading equipment.

Perhaps the best-known freighter innovation aimed at slashing cargo-handling costs is the so-called roll-on, roll-off carrier which had its beginnings as a landing craft in World War II. More than half a dozen companies, mostly small, are operating such vessels, mostly converted landing craft and all toting truck trailers.

A specially-designed 570-trailer ship planned by American-Hawaiian Steamship would be capable of unloading in 10 hours, compared with as least 2-1/2 days for a conventional cargo ship of similar capacity. If the company gets the Federal loan guarantees it's seeking, it proposes to construct 10 such ships to ply between America's East and West Coasts.

Versatile Fleet

A versatile fleet of ships is currently being finished off by the Gotaverken shipyards in Sweden for a Stockholm steamship operator known as Grangesberg-Oxelosund Trafik A/B. The vessels, believed to be the first of their kind ever built, are to be capable of transporting a wide variety of dry bulk commodities – ranging in density from grain to heavy ores. One was delivered in December, with four more due to come off the ways soon.

A big stumbling block in the way of such vessels before has been the difficulty of cleaning their holds preparatory to the loading of a different kind of cargo. The cleaning task is rendered particularly difficult by the many flanges, braces, diagonal supports and other structural stiffeners and partitions such ships require for seaworthiness. Gotaverken's ships have false, smooth hulls inside their ordinary skins, the three feet of space between the two hulls being designed to carry ballast when the ships are full of light commodities or partially empty.

Gotaverken's ships are also being equipped with portable bulkheads that can be secured under the deck when ore is being carried or mechanically set in upright position to prevent shifting when grain is the cargo. Otherwise, it has no posts or other barriers to break the wide, smooth expanse of its huge holds.

VIII. TRANSPORTATION IMPROVEMENTS NEEDED FOR ECONOMIC RESOURCE DEVELOPMENT

The analyses in preceding chapters – especially Chapters V and VI – have endeavored to indicate the types of improved transportation facilities needed for projected exploitation of the resources of Northwest North America in the next 20 years. Chapter VII has outlined the existing transportation facilities and commodity flow in the Area, together with planned improvements or additions in the foreseeable future. What do these transportation needs for resource development add up to, over and above those facilities presently there and those planned for the future?

It would be well to repeat here the major specifications guiding Battelle's analysis and conclusions with respect to improved transportation needs of the Area. As mentioned in Chapter II under "Objective and Scope", the purpose of the study was to stress the determination of "most feasible and direct major and feeder routes for rail and/or additional highway facilities in relation to economic benefits to be derived therefrom by the U. S., Canada, and Alaska, taking into consideration the proximity to such routes of suitable sites for airfields." This was to be followed by cost estimates of selected improved facilities, and comparisons of these costs with projected benefits to determine economic feasibility. It should also be pointed out that Battelle's studies on costs versus benefits could be done on only the relatively few routes that appeared to have the highest degree of economic feasibility, even though the study specifications did not mention this. It would be far beyond the scope of the study, in terms of time and funds, to probe into detailed cost-benefit ratios for all the existing and possible routes.

As also pointed out in Chapter II, major attention was devoted to transportation facilities, new or improved, that would link Alaska with the southern 48 states, together with major feeder routes tying to such a link. At the direction of the Commission, those routes that are intra-Alaska or intra-provincial or -territorial were given only minor consideration in the final cost-benefit studies.

The analyses of the major resources have indicated, by and large, that developments based on known resources will occur over the next 20 years in areas along or close to the coast. This is true for metals and minerals, forests, coal, oil and gas, and fish. It is further concluded that any major freight movements that may develop as a result of future mineral discoveries in the regions back from the coast in Alaska, Yukon Territory, and in northwestern British Columbia could be routed most economically to the coast and thence to markets by water shipment. This, then, left one major economic development potential in the Area — tourism — as virtually the sole, likely beneficiary of major new or improved land-transportation linkages between Alaska and the southern 48 states.

The sections that follow in this chapter will present descriptions of the main improved transportation facilities considered in the study, with estimates of costs given in detail for those improved facilities that will be recommended later. Also included is a brief analysis of why certain new facilities were not studied in detail with respect to preferred location and cost, especially a railroad link, as a transportation need for resource development.

Highways

As mentioned earlier in this chapter, needs for improved major transportation links between Alaska and the south 48 states for development of resources of the Area are tied almost entirely to the potential for expanded tourism. In this respect, the need is for an improved hard-surfaced or paved highway that would minimize the hazards, discomforts, and operational costs caused by heavy dust and flying gravel, and provide all-around more comfortable travel. With more and more advertisements appearing in popular magazines boasting about superior tire wear over the most severe road test in northern North America – the Alaska Highway – it is nothing less than miraculous that this route enjoys as much travel as it now does!

With the further realization that heaviest Alaskan travel is between Alaska and the West Coast states, consideration was next given to studying the feasibility and advantages of a shorter highway between, say, Seattle and Fairbanks. Virtually no conceivable route throughout this area has been overlooked by governmental agencies of British Columbia, Alaska, the United States, and Canada in the numerous engineering feasibility studies and in proposals for road-building programs that have been made in the past. Those that appeared to bear directly on the question of providing access by land for residents and tourists travelling to and from Southeastern Alaska as well as between Seattle and Fairbanks were given special attention in the Battelle economic feasibility study.

Further, the one existing major highway outlet from Southeastern Alaska – the Haines Cutoff – is now open only for about 6 months out of the year, from around mid-May to mid-November. Snow removal – mainly in British Columbia and parts of the Yukon stretches on this highway – has been reported to be a serious problem (snowfalls of as much as 60 feet) and suggestions have been made that minor relocations would facilitate this. If a year-round ferry service from Haines to Prince Rupert is inaugurated, as planned, it would be imperative that the Haines Cutoff be kept open the year around.

Finally, in evaluating the advantages of a paved-highway link between Alaska and the southern 48 states, consideration should properly be given to comparative costs of maintaining a primary gravel highway and a paved highway.

The task of providing data on preferred location and estimated costs of constructing highways under consideration, plus data on maintenance costs of gravel versus paved highways in general, was subcontracted by Battelle to Brown & Root, Inc., of Houston, Texas, in April, 1960. Results of their field and office studies of these problems are incorporated in the following discussion, and their complete report is included as Supplement I of this report.

Comments on Highway Construction

The basic purpose of the Brown & Root survey was to develop reasonably realistic estimates of cost for the construction of a shorter highway connection between the Pacific Northwest states and Alaska and less refined data on certain roads in Alaska which have been advocated as being essential to the economic development of the State. In addition to preparing estimates of costs for constructing gravel-surfaced roads, estimates covering the cost of paving or hard surfacing the new routes and the existing route have been prepared. The report also covers a route which would connect Petersburg, Alaska, with the Stewart-Cassiar Road in British Columbia. Estimates are also presented to show the cost of upgrading the existing Haines Cutoff road to a standard that would warrant keeping the route open to traffic the year around. Cost estimates for paving or hard surfacing this route were likewise prepared. Cost estimates covering the routes in western Alaska are for a lower type of road, frequently referred to as "pioneer" or "development" roads. Finally, rough estimates were made of costs for connecting new routes through British Columbia with a Juneau-British Columbia border road up the Taku River.

An attempt has also been made to present realistic estimates of annual costs for maintaining paved highways versus those for maintaining gravel-surfaced roads. The lack of basic cost data upon which to base estimates leaves these figures open to debate.

In addition to the usual problems which confront builders of roads and highways, the northwest part of the North American Continent imposes added difficulties in the nature of prolonged periods of extremely low temperatures; heavy snowfalls, particularly in the coastal regions; severe icing conditions; numerous and extensive muskegs; permafrost conditions in the northern stretches; and an excessive amount of road to be built to connect traffic-generating centers.

Funds available for road-building purposes have been inadequate to the point of being scanty. Those charged with the responsibility of building roads have tried to stretch the dollars over as many miles of road as was humanly possible in an effort to span the great distances. In accomplishing this end, many maintenance problems have been built into the highways. That is, many sections of the roads were constructed on locations where lowest construction costs would be encountered without proper consideration given to subsequent maintenance costs. Then generally throughout, side ditches were constructed with minimum cross-sectional area and back slopes cut at steep angles. Likewise, side slopes on fill sections were steep with narrow shoulders. These practices, coupled with the practice of establishing profile grade lines which closely approximated the natural ground line, resulted in considerable savings in excavation quantities which permitted the construction of more miles of roads. Also in order to conserve funds, too few culverts were installed and provision of facilities for diverting seepage water from the roadbed was, to a marked degree, neglected. These may be considered as sound practices in the construction of a gravel-surfaced road; however, in order to provide a soundly engineered highway having relatively low maintenance costs, these defects and omissions <u>must</u> be rectified before an expensive pavement is applied. For this reason, the estimates for paving include an average per mile cost for this reconditioning and preparatory work on those sections of existing gravel roads which are considered as a part of a paved through highway.

It is to be noted that, in choosing new road locations, all agencies in the Northwest region charged with the responsibility of highway and road construction are now adhering to the sound policy of carefully picking routes over the more stable areas and establishing horizontal and vertical alignments that will permit of the thoroughfare being subsequently raised to higher standards without the necessity of relocating and reconstructing large portions of the highway.

These agencies now have laboratory facilities and experienced soil technicians to ensure that locations having the most desirable soil characteristics can be determined before the route is definitely established. Better control of embankment, subgrade, and base materials used in the construction of the roads is also assured through these practices.

Connection Over "A" Route

There are several feasible locations for a highway connection from Hazelton, B.C., passing through the vicinity of Telegraph Creek, B.C., continuing through Atlin, B.C., and connecting with the existing Alaska Highway at Jakes Corner in Yukon Territory. An alternate route, suggested by the British Columbia Highway Department, connecting the Stewart-Cassiar Road north of Dease Lake with the Alaska Highway east of Teslin, is also covered.

The locations which were investigated are shown as either "Studied" or "Recommended" on Figure VIII-1. The Stewart-Cassiar Road, portions of which are used in each of the routings, is shown as "Under Construction or Programmed". It will be noted that junction points, and certain other focal points have been given letter designations. This was done to facilitate tracing the various routings between Hazelton (Point A) and Jakes Corner (Point K).

Distances and estimates of cost were computed and compiled by sections corresponding to those shown in Figure VIII-1. Due to changes in topography the various sections, in many instances, were divided into units for costing purposes. Detailed cost breakdowns covering grading, drainage structures, pit-run gravel surfacing, and engineering for each of the routes considered are given in Supplement I.

By using the sections shown in Figure VIII-1 there are eight possible routings between Points A (Hazelton) and K (Jakes Corner). These are numbered 1 through 8 in Table VIII-1, which traces the routings by letters as shown on Figure VIII-1, and gives estimated total costs for (1) a finished gravel highway, (2) a highway with an asphalt-treated surface, and (3) a highway paved with 2 inches of hot-mix asphaltic concrete. In each instance the mileage between Hazelton and Jakes Corner, and between Seattle, Washington, and Fairbanks, Alaska, have been shown. This permits an easy comparison of travel distances and over-all estimates of cost of the various routes.

The highway constructions described by the three categories mentioned above are as follows:

(1) Gravel. A gravel-surfaced road comparable in width and quality with the Stewart-Cassiar Road which is presently being constructed by the Canadian Government in northern British Columbia. Although primarily a "Development Road" it is being constructed to standards which will permit it to be readily upgraded to primary highway classification. Careful attention is being given to principal location factors such as horizontal and vertical alignment, and sight distances. Also careful consideration is given to the soils that will form the foundation of the roadway. The roadway, with minor exceptions in solid rock cuts, is being constructed to a crown width of 28 feet and plated with approximately 6 inches of pit-run gravel with all cobbles larger than 3 inches screened out before the material is placed on the roadway. Although temporary Bailey bridges and ferries are being installed at the major stream crossings, to facilitate construction of the road, permanent structures meeting primary highway specifications will be installed subsequently.

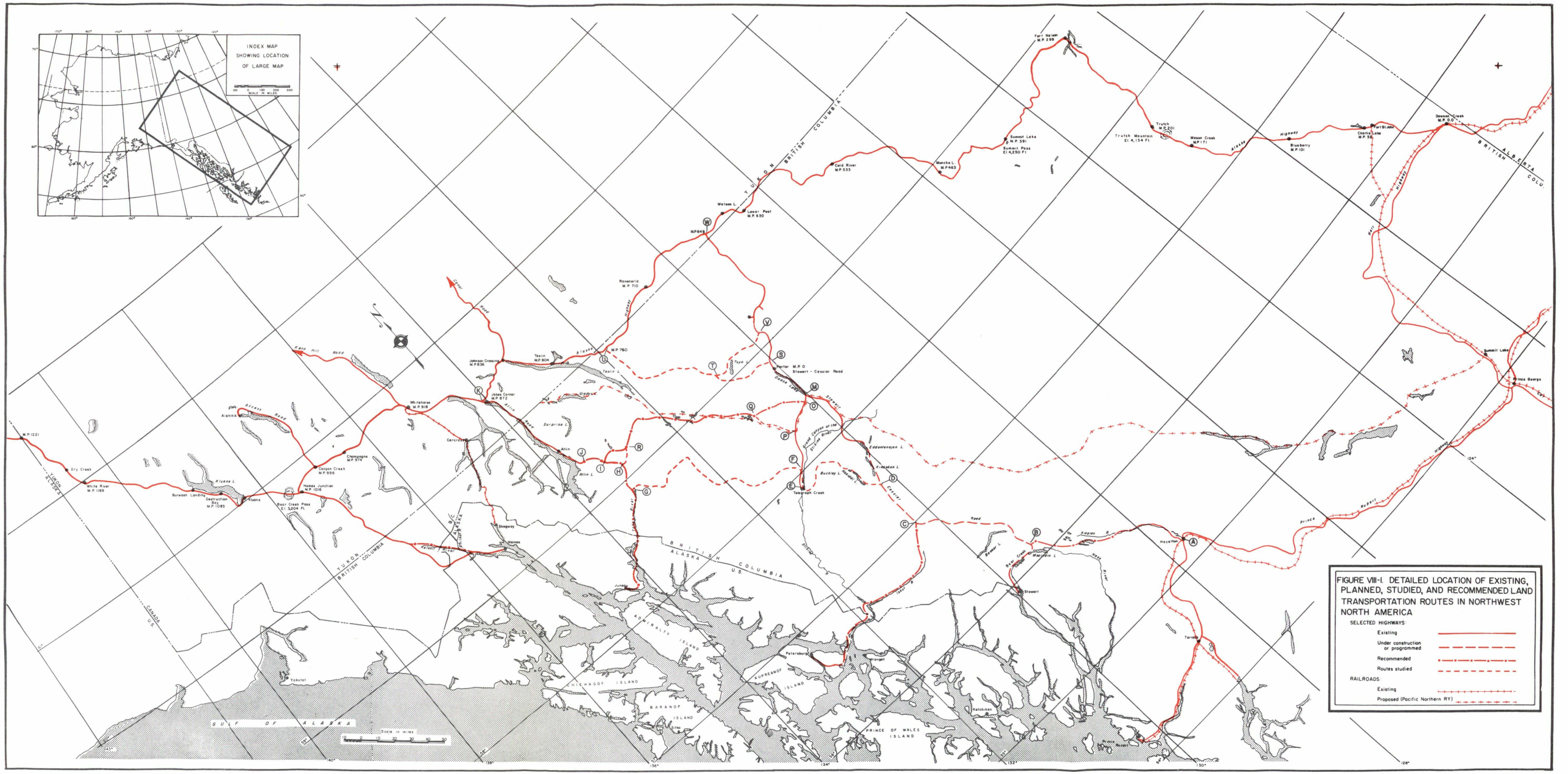

FIGURE VIII-1. DETAILED LOCATION OF EXISTING, PLANNED, STUDIED, AND RECOMMENDED LAND TRANSPORTATION ROUTES IN NORTHWEST NORTH AMERICA

SELECTED HIGHWAYS:
- Existing
- Under construction or programmed
- Recommended
- Routes studied

RAILROADS:
- Existing
- Proposed (Pacific Northern RY)

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TABLE VIII-1. ESTIMATED COSTS AND DISTANCES FOR THREE TYPES OF ROADS OVER VARIOUS ROUTE LOCATIONS STUDIED BETWEEN HAZELTON, B. C., AND JAKES CORNER, YUKON TERRITORY, TOGETHER WITH THE ALASKA HIGHWAY

Route	Route Location	Mileage, Seattle-Fairbanks	Estimated Total Cost for Type of Road Indicated, million dollars: Gravel	Asphalt Surface Treated	Asphaltic Concrete	Mileage, Hazelton-Jakes Corner
1	ABCDEF GHIJK	2106	50.3	114.5	151.0	573
2	ABCDMOP QRHIJK	2118	31.5	98.5	132.5	585
3	ABCDMOP QRIJK	2107	25.3	91.7	126.1	574
4	ABCDMO QRHIJK	2092	29.6	95.0	128.8	559
5	ABCDMO QRIJK	2081	23.5	88.1	121.4	548
6	ABCDMS TUK	2096	17.8	87.4	121.4	563
7	ABCDMS VTUK	2128	17.4	89.3	124.6	595
8	ABCDMS VWUK	2194	6.9			661
Alaska Highway		2367	30.8[a]	102.3	152.5	

(a) Cost of relocations, line changes, and bridge replacements necessary to provide a gravel road comparable to others shown.

(2) Asphalt Surface Treatment. A paved, or hard-surfaced, highway of secondary classification with 24-foot riding surface and a minimum 2-foot shoulder on each side. Surface of road treated with a base primer of cutback liquid asphalt and one or more applications of liquid asphalt covered with graded stone chips. Estimates based on 9-inch average depth of base material, a prime coat of asphalt, and two light applications of asphalt and chips.

(3) Asphaltic Concrete Pavement. This represents a paved highway of primary classification having a 24-foot riding surface and a minimum 2-foot shoulder on each side. Surface of road treated with base primer prior to application of asphaltic concrete mixture. Estimates based on 18-inch average depth of base materials, prime asphalt coat, and 2 inches of hot-mix asphaltic concrete.

From a careful review of the various routes studied by Brown & Root, Battelle is in agreement with their analyses and conclusions which follow.

Routes 1, 2, 3, 4, and 5 are the lines which follow essentially the so-called "A" route. Route 5 has the shortest travel distance - 2,081 miles between Seattle and Fairbanks. Of these five routes, Route 5 also has the lowest estimate of cost for both a gravel highway and for both types of paved highways. Therefore, Routes 1, 2, 3, and 4 were dropped from consideration and Route 5 was used in the final comparison.

The effects of Route 5 on the cost of a link connecting Juneau will be discussed in a later paragraph. Comparing Routes 6 and 7, Route 7 is found to be 32 miles longer with no appreciable savings in cost as a paved road; therefore, Route 7 was discarded.

Route 8 is presented only as a "stop-gap" measure. Under this proposal, a road joining Points A and B if scheduled for a completion date corresponding with the opening of the Stewart-Cassiar Road, would provide a gravel-surfaced route between Seattle and Fairbanks, shorter by 173 miles than the present route at a cost of only $7 million. As this section is common to all the routes studied, nothing would be lost through the early closing of this gap.

In the final comparison, Routes 5 and 6 both have travel distance advantages by 286 and 271 miles, respectively. Route 6 has a decided cost advantage if built as a gravel road; however, when paving is considered neither has any advantage over the other.

Route 6 would provide an improved shorter haul for the Cassiar mineral region. However, construction of Route 5 would provide access to large areas favorable for mineral exploration, as shown in Figure V-10, while at the same time offering an alternate route for the Cassiar mineral region. Route 5 offers much better scenic attractions than does Route 6.

Route 5 would provide reasonably close access for a highway outlet eastward from Juneau up the Taku Inlet and River, connecting Juneau with an "A" route highway. Cost estimates comparing Routes 1 and 4 and 1 and 5 show that substantial savings would be effected - $15 to $18 million - by construction of the through highway on either Route 5 or 4 and adding the intervening gap to the Juneau portion of the road.

In each instance the travel distance between Juneau and Fairbanks would not be changed substantially. Route 4 would increase the travel distance from Juneau to Seattle by 26 miles while Route 5 would cause an increase of 47 miles.

All things considered, Route 5 offers more advantages than any of the other locations studied along the so-called "A" route.

When making a long-range evaluation of the over-all scene, this thought should be considered - that should a new and shorter route be constructed, the probabilities are that it would be necessary and desirable to maintain the present highway as an alternate route, in which case the annual maintenance appropriation would have to be increased by an amount sufficient to care for the mileage added by construction of the new route.

Description of Route 5. Since Route 5 was selected as the preferred location for linking Hazelton with the Alaska Highway at Jakes Corner, a brief description of this route, as given by Brown & Root, follows.

From Seattle through Prince George to Hazelton this route is over existing paved highways in the State of Washington, U. S. A., and mostly over paved highways in the Province of British Columbia, Canada. From Hazelton, Point A, to a connection at Point B with the authorized Stewart-Cassiar Road the route traverses the broad glaciated valleys of the Kispiox and Nass Rivers. This route would follow an existing road (requiring upgrading) to approximately 20 miles north of Hazelton. The remainder would be new construction. Construction on this section would be relatively easy. No highway construction is easy in the northwest region - hence "easy" as used here is relative to the subject area.

Portions of the Stewart-Cassiar Road would be used between Points B-C, C-D, and D-M. A short portion of the present Telegraph Creek Road would be used for M-O, but would require considerable upgrading.

Sections O-Q and Q-R traverse plateau country that is fairly easy going. Incidentally, for about 75 miles this route northwestward from Point Q follows the same general location as the proposed Pacific Northern Railway (Wenner-Gren). In order to reach Atlin, Route 5 crosses an easy low divide to the Nakina River valley, continuing along the Nakina River over fair ground to Point R. Section R-I traverses relatively easy country through a broad glaciated valley. This route avoids the exceptionally rough terrain and costly construction along the Nakina canyon country in Section R-H, and almost equally costly construction through Section H-I, which follows the Salmon River over rough, broken, glaciated, rocky benches with little overburden.

Section I-J crosses the O'Donnell River valley to connect with the existing dirt road south of Atlin, offering fairly good going. Between Points J and K (Jakes Corner on the Alaska Highway), the existing road would be used, with some upgrading.

From Jakes Corner, the route follows the Alaska Highway to Whitehorse and thence to Fairbanks. Total distance from Seattle to Fairbanks is 2081 miles, shorter by 286 miles than the present Alaska Highway route.

Cost Estimates for Route 5. Details of cost estimates prepared by Brown & Root for Route 5 are given in Table VIII-2, which shows not only a breakdown of costs into various categories, but also the same cost breakdown for the various sections of the route indicated by letters on Figure VIII-1. Similar cost tables are given for each of Routes 1 through 8 in Supplement I.

Total cost of the asphalt-surface-treated road amounts to $88.1 million. Included in this cost are bridge replacements ($2.6 million) and road relocations and line improvements ($3.7 million) for the Alaska Highway between Jakes Corner and the Yukon-Alaska boundary – improvements that have been included in the annual maintenance program of the Royal Canadian Engineers in the past, and that have been programmed for the next six years.

Alaska Highway

In considering the improved highway linkage between Alaska and the southern 48 states for tourism development, study necessarily was made of the comparative costs and benefits of paving the present Alaska Highway to provide safer, cheaper, and easier driving conditions. As is well known, this thoroughfare is the result of a war emergency "crash" program. Factors other than the selection of the shorter or more logical location for a highway to serve peacetime needs influenced the routing of the present highway.

During the years following the cessation of World War II hostilities, an improvement program has been in effect. This consists of: the replacement of temporary drainage structures, both bridges and culverts; vertical and horizontal alignment changes; sections of the highway being reconstructed on new and better locations; and stabilization of slide areas in those places where changing the position of the roadway is not deemed practical or economical. Due to the many miles involved, however, much work of this nature still remains to be done. Estimated costs of performing these operations, plus paving the Alaska Highway with either an asphalt surface treatment or a 2-inch asphaltic concrete pavement are given in Table VIII-3.

To facilitate the comparisons of travel distances and costs, the existing Alaska Highway was divided into units for which costs are given in Table VIII-3. This division was necessary for several reasons: (1) the various proposed alternate routings did not all embrace the same portions of the existing road; (2) existing physical conditions required different cost-estimate units; (3) the section of road between Dawson Creek and Charlie Lake has been paved and hence is not included in the columns giving the estimated costs of paving or surfacing; and (4) the section between Haines Junction and the Alaska-Yukon boundary was split at Mile Post 1100, as this is the approximate beginning of the permafrost region on the upper reach of the highway.

Cost of upgrading and providing an asphaltic surface treatment of the Alaska Highway from Charlie Lake to the Alaska-Yukon boundary is $102.3 million, and cost of paving it with 2 inches of asphaltic concrete is $152.5 million. Cost of upgrading and asphalt-surface-treating the section from Charlie Lake to Jakes Corner is estimated at $74.4 million, which includes $14.3 million for bridge replacements and $10.2 million for relocations and line improvements. Additional detailed discussion of the costs cited above, together with specific bridge requirements and locations, etc., are given in Supplement I.

Stikine-Iskut River Route

Need for a highway connection between one or more points in Southeastern Alaska and the mainland lying to the east and south has been recognized for years. The Haines Cutoff serves this function for the northern portion of Southeastern Alaska during the 6 months it is open. But the long water trip and circuitous land journey via the Alaska Highway leave much to be desired. Prince Rupert provides a more direct outlet for the southern end. The Coast Mountains stand as a formidable barrier to such connections, except along a few river valleys that cut through the mountains.

Once the planned ferry service in Southeastern Alaska is inaugurated, such a land connection would certainly: (1) provide an attractive "circle route" for tourists who might wish to take a short British Columbia-Alaska trip by car via a combination of highway and ferry boat, and (2) allow residents in Southeastern Alaska to utilize such a combined ferry and highway route for travelling to and from their homes via automobile, in contrast with their present complete dependence on air travel or summer cruise ships. Moreover, such a land connection would permit shipment of frozen or refrigerated fish from this important fishing-area direct to midwest markets via refrigerated trucks, with perhaps refrigerated meat, farm produce, or general merchandise providing a return cargo.

Major natural "gateways" through the Coast Mountains from the east to Southeastern Alaska are (1) the Stikine River, and (2) the Taku River. Both of these routes have received consideration for highway locations for many years, and reconnaissance surveys have been made of those parts of the routes lying within Alaska. Since roads over these routes appeared to offer substantial benefits to the area, studies of preferred location and costs for portions of these routes lying in British Columbia were requested of Brown & Root.

Major advantages of the Stikine route are: (1) it offers the shortest cut-through to the Stewart-Cassiar road now under construction, and (2) it lies almost midway between the southern and northern limits of Southeastern Alaska.

As already mentioned, this route has been studied, and work has been started on it by the U. S. Bureau of Public Roads and the Alaska Division of Highways, evidenced by past construction of a road south from Petersburg to the southern coast of Mitkof Island near Blind Slough, from which point engineering design studies have been made for a road running eastward along the south shore of Mitkof Island, thence by bridge across Dry Strait, and eastward up the north bank of the Stikine River to Popof Creek – just east of Kakwan Point. Provision for grading and drainage of a secondary road to this point ($4,000,000), plus a $2,000,000 bridge across Dry Strait, is included in the present 5-year program for secondary roads of the Alaska Division of Highways.

From Popof Creek eastward to a connection with the Stewart-Cassiar Road, three generally different routes might be followed. One would follow the Stikine River north and northeast via Telegraph Creek to Dease Lake for the junction; the other two would follow the Stikine to the mouth of the Iskut, thence east and northeast – either on the north or south side – to the most southerly point where the Stewart-Cassiar Road follows the Iskut River valley. To choose ultimately between the north or south side of the Iskut would require detailed engineering studies.

Choice between the Stikine route to Dease Lake via Telegraph Creek and the Stikine-Iskut route was not difficult. Distance of new road construction would be much less via the Iskut, and the latter offers easier construction. Furthermore, the Iskut

TABLE VIII-2. DETAILED COST ESTIMATES

(1)	(2)	(3)	(4)	(5)	(6)
Section	Mileage	Estimated Cost Grading, Drainage Structures and Gravel Surface(a)	Reconditioning Existing Substandard Roads(a)	Total Estimated Cost, Columns 3 and 4 (Gravel Road)	Reconditioning Preparatory to Paving or Surfacing
Seattle — Prince George	582	$ 0	$ 0	$ 0	$ 0
Prince George — Hazelton	297	0	0	0	0
A (Hazelton)-B	99	6,901,900	0	6,901,900	3,811,500
B-C	80	0	0	0	3,080,000
C-D	33	0	0	0	1,270,000
D-M	81	0	0	0	3,118,500
M-O	7	0	231,000	231,100	269,500
O-Q	33	3,037,200	0	3,037,200	1,270,500
Q-R	103	7,369,200	0	7,369,200	3,965,500
R-I	18	1,821,000	0	1,821,000	693,000
I-J	13	1,428,300	0	1,428,300	500,500
J-K (Jake's Corner)	81	0	2,697,000	2,697,000	3,118,500
Jakes Corner — Haines Junction	144	0	0	0	7,155,500
Haines Junction — M.P. 1100	84	0	0	0	3,701,500
M.P. 1100 — Alaska Boundary	121	0	0	0	7,034,500
Alaska Boundary — Fairbanks	305	0	0	0	0
Totals	2081	$20,557,600	$2,928,000	$23,485,600	$38,989,000

(a) To standards comparable to the Stewart-Cassiar Road.
(b) In this instance an average of 18 inches of base material and 2 inches of hot-mix asphaltic concrete pavement.
(c) For applying an average 9-inch base course with asphalt surface treatment.

FOR ROUTE 5, HAZELTON TO FAIRBANKS

(7) Estimated Cost Base and Flexible Pavement[(b)]	(8) Total Estimated Cost, Columns 3, 4, 6, and 7 (Asphaltic Concrete Road)	(9) Estimated Cost Base Surface Treatment[(c)]	(10) Total Estimated Cost, Columns 3, 4, 6, and 9 (Asphaltic-Surface-Treated Road)	Remarks
$ 0	$ 0	$ 0	$ 0	Existing paved highway
0	0	0	0	75% paved
7,078,500	17,791,500	2,831,400	13,544,800	New construction
5,720,000	8,800,000	2,288,000	5,368,000	Stewart—Cassiar Road, Authorized or under construction
2,359,500	3,629,500	943,800	2,213,800	Ditto
5,791,500	8,910,000	2,316,600	5,435,100	"
500,500	1,001,000	200,200	700,700	Telegraph Creek Road, existing, substandard
2,359,500	6,667,200	943,800	5,251,500	New construction
7,364,500	18,699,200	2,945,800	14,280,500	Ditto
1,287,000	3,801,000	514,800	3,028,800	"
929,500	2,858,300	371,800	2,300,600	"
5,791,500	11,607,000	2,316,600	8,132,100	Atlin Road, existing, substandard
10,296,000	17,451,500	4,118,400	11,273,900	Alaska Highway, gravel surface
6,006,000	9,707,500	2,402,400	6,103,900	Ditto
3,460,000	10,495,100	3,460,600	10,495,100	"
0	0	0	0	Pavement or alphalt surface treatment over entire route
$58,944,600	$121,418,800	$25,654,200	$88,128,800	

TABLE VIII-3. ESTIMATED COSTS OF UPGRADING AND PAVING THE

(1) Section	(2) Unit	(3) Mileage	(4) Bridge Replacements, Lump Sum	(5) Relocations and Line Improvements	(6) Preparing Roadway for Paving or Surfacing	(7) Totals, Columns 4, 5, and 6
Seattle-Prince George	--	582	--	--	--	--
Prince George-Dawson Creek	--	259	--	--	--	--
Dawson Creek-Charlie Lake	1	52	$ 990,000	--	--	$ 990,000
Charlie Lake-M.P. 649	2	597	9,410,500	$ 7,238,000	$19,365,500	36,014,000
M.P. 649-M.P. 760	3	111	572,000	1,617,000	3,465,000	5,654,000
M.P. 760-Jakes Corner	4	112	3,355,000	1,309,000	3,657,500	8,321,500
Jakes Corner-Haines Junction	5	144	1,034,000	1,155,000	4,966,500	7,155,500
Haines Junction-M.P. 1100	6	84	121,000	693,000	2,887,500	3,701,500
M.P. 1100-Alaska Boundary	7	121	1,452,000	1,848,000	3,734,500	7,034,500
Alaska Boundary-Fairbanks	--	305	--	--	--	--
Total (Seattle to Fairbanks)		2367	$16,934,500	$13,860,000	$38,076,500	$68,871,000

Summation

Schedule 1. Upgraded Gravel Road	
Column 4	$16,934,500
Column 5	13,860,000
Total Estimated Cost	$30,794,500

Schedule 2. Asphaltic
Columns 4, 5, and 6
Columns 8 and 9
Total Estimated Cost

ALASKA HIGHWAY, DAWSON CREEK TO ALASKA-YUKON BOUNDARY

(8) Crushed Gravel Base Course (Average 18 in. Thick)	(9) 2-In. Hot-Mix Asphaltic Concrete Pavement	(10) Totals Columns 8 and 9	(11) Crushed Gravel Base Course (Average 9 In. Thick)	(12) Asphalt Surface Treatment	(13) Totals, Columns 11 and 12	(14) Remarks
--	--	--	--	--	--	Existing paved highway
--	--	--	--	--	--	Largely unpaved
--	--	--	--	--	--	Roadway paved; two semipermanent bridges
$26,268,000	$16,417,500	$42,685,500	$13,134,000	$3,940,200	$17,074,200	Existing gravel road
4,884,000	3,052,500	7,936,500	2,442,000	732,600	3,174,600	Ditto
4,928,000	3,080,000	8,008,000	2,464,000	739,200	3,203,200	"
6,336,000	3,960,000	10,296,000	3,168,000	950,400	4,118,400	"
3,696,000	2,310,000	6,006,000	1,848,000	554,400	2,402,400	"
5,324,000	3,327,500	8,641,500	2,662,000	798,600	3,460,600	"
--	--	--	--	--	--	Pavement or asphalt surface treatment over entire route
$51,436,000	$32,147,500	$83,583,500	$25,718,000	$7,715,400	$33,433,400	

Concrete Paved Road

	$ 68,871,000
	83,583,500
	$152,454,500

Schedule 3. Asphalt-Surface-Treated Road

Columns 4, 5, and 6	$ 68,871,000
Columns 11 and 12	33,433,400
Total Estimated Cost	$102,304,400

route offers a direct route to the east to a junction with the Stewart-Cassiar Road, from which point traffic could move with equal ease to north or south. There is little doubt that most traffic into and out of Petersburg would move from and to the south rather than the north, and to utilize the route via Dease Lake and Telegraph Creek would involve extra travel of around 300 miles. For these reasons the Stikine-Iskut route was studied and cost estimates prepared for the north bank route. Estimated costs are given in Table VIII-4. General location of the road is shown in Figure VIII-1.

From Popof Creek to the Stewart-Cassiar junction is estimated at 96 miles. Costs of the same three types of road, as explained in earlier discussion of the "A" route complex, are estimated as follows:

Road Type	Cost, $ million
Gravel	17.5
Asphalt surface treated	23.8
Asphaltic concrete	27.7

Estimated costs of the separate sections in Alaska and British Columbia are shown in Table VIII-4. About 85 per cent of the costs for each type of road starting at Popof Creek are involved in the Canadian section.

Scenic attractions along this route are outstanding. Even more important, the route skirts the southerly part of an area described as a potential "copper province", as mentioned in the copper discussion in Chapter V. Although the few deposits that appear to offer most promise are in the Scud River valley (flowing eastward from the Stikine some 40 miles north of the mouth of the Iskut) and Mess Creek farther to the northeast, a road up the Stikine and Iskut would provide a year-round outlet to deep salt water along the south coast of Mitkof Island. Access roads from the mouth of the Iskut to such copper mines as may be developed could be constructed after more development proves their economic worth as ore deposits. Existence of the Stikine-Iskut highway should serve as a spur to explore these several promising copper areas more completely to prove or disprove their economic value.

Haines Cutoff

Consideration of improvements for the Haines Cutoff running from Haines, Alaska, to Haines Junction, Yukon Territory, on the Alaska Highway revolves around the need for and desirability of keeping it open throughout the year. Up to the present it is closed to traffic from about mid-November to mid-May – about 6 months out of the year. Commercial and industrial enterprises, dependent on distribution of petroleum products, lumber, building materials, and other general merchandise over the highway to areas in the Yukon, are severely handicapped by this long closed period.

Inauguration of year-round ferry service to ports in Southeastern Alaska would necessitate keeping the Haines Cutoff open through the winter. For this reason, Battelle requested Brown & Root to make a reconnaissance of an improved route that would facilitate winter maintenance of the Haines Cutoff.

TABLE VIII-4. ESTIMATED COSTS OF GRAVEL, ASPHALT TREATMENT, AND 2-INCH SLAB PAVEMENT FOR THE STIKINE-ISKUT RIVER ROAD

(1) Section	(2) Mileage	(3) Estimated Cost of Grading, Drainage Structures, and Gravel Surface[a]	(4) Reconditioning Existing Substandard Roads[a]	(5) Total Estimated Cost, Columns 3 and 4	(6) Reconditioning Preparatory to Paving or Surfacing	(7) Estimated Cost Base and Flexible Pavement[b]	(8) Total Estimated Cost, Columns 3, 4, 6, and 7	(9) Estimated Cost Base and Surface Treatment[c]	(10) Total Estimated Cost, Columns 3, 4, 6, and 9
Petersburg-Popof Creek[d]	--	--	--	--	--	--	--	--	--
Popof Creek-British Columbia Border	15	$ 2,706,000	--	$ 2,706,000	$ 525,000	$1,072,500	$ 4,303,500	$ 456,000	$ 3,687,000
Alaska-British Columbia Border to Stewart-Cassiar Road	81	14,800,500	--	14,800,500	2,835,000	5,791,500	23,427,000	2,462,400	20,097,900
Total	96	$17,506,500	--	$17,506,500	$3,360,000	$6,864,000	$27,730,500	$2,918,400	$23,784,900

(a) To standards comparable to the Stewart-Cassiar Road.
(b) In this instance an average of 18 inches of base material and 2 inches of hot-mix asphaltic concrete.
(c) For applying an average 9-inch base course with asphalt surface treatment.
(d) Built, under construction, or programmed.

The distance between Haines and Haines Junction is 159 miles, 42 of which are in Alaska, approximately 53 miles in British Columbia, and the remaining 64 miles in Yukon Territory.

The entire Alaska portion of the highway is paved. The section between the Chilkat River and the British Columbia boundary, however, is of poorer quality than the section between Haines and the Chilkat River. The Coast Mountains are crossed in the British Columbia part of the route. This section of the road was built to low standards on poor alignment, both vertical and horizontal. Snowfall is heavy – 58 feet in the 1959-1960 winter at the pipeline booster station 6 miles north of the Alaska border, and probably more in the mountain passes. Much of the roadway was built in the trough of the canyons, making snow removal very difficult because of the lack of suitable disposal areas. The Canadian government has been reluctant to attempt keeping the road open in winter for this reason.

The Yukon portion, although of low standard, is built on fairly good alignment; considerable upgrading would be required on this section even for winter maintenance as a gravel road.

Several studies have been made and reports prepared on new locations across the mountains, aimed especially at facilitating snow removal. Of the routes studied, the "high" Kelsall River location seems to be most favored both from a construction-cost and winter-maintenance standpoint, even though it would necessitate abandonment of the already paved part between the Chilkat River and the British Columbia border.

The main disadvantage in choosing this location is that the U. S. Armed Services Oil Products pipeline follows the existing highway route. A pumping station is located adjacent to the highway approximately 6 miles north of the Alaska-British Columbia border, making it necessary to keep this portion of the existing road open all year to provide ingress and egress to the pipeline station.

The spectacular scenery along this or the relocated route should make the drive very attractive to tourists, and the relocated route would be 16 miles shorter than the present route. Another major advantage would be expeditious snow removal.

The relocated portion of the route, amounting to 40.5 miles, is shown on Figure VIII-1, and a cost breakdown for rebuilding the entire road to the following standards is given in Table VIII-5: gravel – $9.1 million; asphalt surface treatment – $16.5 million; and asphaltic concrete – $18.5 million.

Taku River Road

Because of the continued interest in the route up Taku Inlet and the Taku River eastward as a direct land-highway connection between Alaska's capital, Juneau, and a highway to the east, consideration was given to preferred location and rough cost estimates for that part of the route lying in British Columbia. The importance of such an eventual road connection was a factor given consideration in the preference of Route 5 over Route 6 in choosing a recommended "A" route road between Dease Lake and Jakes Corner.

Reconnaissance of the portion of the route lying in Alaska has been made, and estimated cost of a gravel road over this section was reported by Downing in 1960 as slightly over $20 million.(1) This covers about 52 miles of road, from the end of the present road to the Alaska-British Columbia border, and includes a necessary ferry and facilities for crossing Taku Inlet to avoid construction and maintenance difficulties caused by the advancing Taku Glacier entering the Inlet from the north. Location of the route is shown on Figure VIII-1.

Estimated cost of an asphalt-surface-treated road from the British Columbia border up the Taku River to Point G, thence to H, and from H to I (Figure VIII-1), where it would join with the proposed Route 5 southeast of Atlin, is $17,600,000. Distance over this route is estimated at 71 miles. Total distance from Juneau to the Route 5 intersection would be about 123 miles, and total estimated cost of the road, including ferry and facilities, is $37,600,000.

In addition to providing residents of Juneau and vicinity a highway connection with the "outside", such a road would surely attract an important number of tourists in autos – providing another possible "circle" tour in combination with the planned ferry service for Southeastern Alaska. The route traverses country with excellent scenic and wildlife attractions and provides a saving of 590 miles plus a ferry and highway trip between Juneau and Seattle when compared with the present route via the Alaska and Haines Highways.

Also, construction of this road might tip the economics in favor of reopening the idle Tulsequah Chief zinc mine just east of the British Columbia border, with possible production of some 30,000 tons of concentrates per year valued at roughly $5 million.

Intra-Alaska Roads

Since the Commission desired that emphasis be placed on major transportation links between Alaska and the southern 48 states, including major feeder routes, less attention was given to needs for facilities within Alaska. Moreover, Alaska's state highway planning group is actively engaged in drawing up an intrastate road program, based on their more intimate knowledge of local and statewide needs.

Alaska already has quite a network of roads that serve present state needs reasonably satisfactorily. The system of hard-surfaced roads is badly in need of major repairs and reconstruction, however, and a very sizable portion of budgeted funds under the Federal-aid program for the next 5 years is earmarked for this purpose.

For future economic growth, involving more intense exploration, discovery, and development of her metal, mineral, and fuel resources, Alaska badly needs more development- or pioneering-type secondary roads. Limited funds are now available for "pioneering access" and "mining access" road programs, to assist resource development, but these are inadequate for meaningful progress.

TABLE VIII-5. ESTIMATED COSTS OF RELOCATING, SURFACE

(1) Section	(2) Mileage	(3) Estimated Cost Grading, Drainage Structures and Gravel Surface[a]	(4) Reconditioning Existing Substandard Roads[a]	(5) Total Estimated Cost, Columns 3 and 4 (Gravel Road)	(6) Reconditioning Preparatory to Paving or Surfacing
Unit 1 Haines - M.P. 23.3	23.3	–	--	--	–
Unit 2 M.P. 23.3 - Goat Creek	40.5	$5,940,500	--	$5,940,500	–
Unit 3 Goat Creek - M.P. 89.5	10.0	–	$1,200,000	750,000	–
Unit 4 M.P. 89.5 - Haines Junction	69.5	–	3,025,000	2,450,000	$ 1,737,500
Total (Haines Cutoff)	143.3	5,940,500	4,225,000	9,140,500	1,737,500
Haines Junction - M.P. 1100	84				3,701,500
M.P. 1100 - Alaska Boundary	121				7,034,500
Alaska Boundary - Fairbanks	305	–	–	--	–
Total (Alaska Highway)	510				$10,736,000
Total (Alaska plus Haines)	653	$5,940,500	$4,225,000	$9,140,000	$12,473,500

(a) To standards comparable to the Stewart-Cassiar Road.
(b) In this instance an average of 18 inches of base material and 2 inches of hot-mix asphaltic concrete pavement.
(c) For applying an average 9-inch base course with asphalt surface treatment.

TREATING, OR ASPHALT-PAVING THE HAINES CUTOFF

(7) Estimated Cost Base and Flexible Pavement[b]	(8) Total Estimated Cost, Columns 3, 4, 6, and 7 (Asphaltic Concrete Road)	(9) Estimated Cost Base Surface Treatment[c]	(10) Total Estimated Cost, Columns 3, 4, 6, and 9 (Asphalt-Surface-Treated Road)	Remarks
--	--	--	--	Existing paved highway
$1,336,500	$ 7,277,000	$ 891,000	$ 6,831,500	Relocation, new construction
330,000	1,530,000	220,000	1,420,000	Reconditioning existing road
4,969,000	9,731,800	3,475,000	8,237,500	Reconditioning existing road
6,635,800	18,538,800	4,586,000	$16,489,000	
6,006,000	9,707,500	2,402,400	6,103,500	Alaska Highway
3,460,000	10,495,100	3,460,600	10,495,100	Ditto
--	--	--	--	Existing highway
$9,466,600	$20,202,600	$ 5,863,000	$16,598,600	
$16,102,400	$38,744,400	$10,449,000	$33,088,000	

It is known that pioneering roads are being given serious consideration in state highway planning, but virtually nothing was included for such roads in the 5-year program as reported to Battelle in August, 1960.

Types of "pioneering" secondary roads that might well be included in long-range state plans are given below. Place names used in this discussion may be located by reference to Figure VII-1.

Browne-McGrath-Ruby-Tanana. Such a road might extend southwestward from Browne (just south of Rex on the Alaska Railroad), skirting the north boundary of McKinley National Park passing through Kantishna and along the north foothills of the Alaska Range to the vicinity of Farewell, thence northwestward to McGrath, north to Poorman and Ruby, and eastward along the Yukon to Tanana. Alaska has already had design studies made for a road from Eureka to Tanana.

Brown & Root made rough cost estimates for a secondary gravel road over this route, summarized as follows:

	Miles	Total Cost
Browne-McGrath	281	$19,593,800
McGrath-Poorman	119	7,476,200
Poorman-Ruby (improvement)	58	4,784,000
Ruby-Tanana	114	7,232,800
Total	572	$39,086,800

Details are given in Supplement I of this report.

This road would skirt promising areas for metal exploration in the Alaska Range (Figure V-10) and penetrate fairly favorable mineral areas in the Kuskokwim Mountains. It would greatly facilitate access to these areas for prospecting, and provide an outlet for mine products once they are discovered and developed. The junction with the McKinley Park-Kantishna road would provide Alaskan auto tourists with a circle route through this famous National Park. The alternative route via Browne gives heavy freight trucks access to the favorable mineral areas along the north side of the Alaska Range - the McKinley Park road. The virtual impossibility of keeping the McKinley Park road open during the winter is another reason why the alternative route would be desirable.

Fairbanks-Nome. The route tentatively chosen by Alaska highway planners for a road joining Fairbanks and Nome would go westward from Eureka to Tanana, thence down the Yukon River valley to a point a few miles west of Ruby, thence north and northwestward across the Koyukuk Slough and River, westward to Haycock, southwestward to Council, thence to Nome over an existing road. Rough estimates by Brown & Root give total cost for a secondary gravel road over this route of $32,500,000. The distance involved in construction, beyond the Eureka-Tanana section now included in state plans, is about 400 miles between Tanana and Council.

By reference to Figure V-10 showing comparative lode mining potential of the Area, it may be seen that the route just sketched traverses rather uninteresting country east of the Seward Peninsula, although it does penetrate a promising petroliferous area (Figure V-12).

An alternative, somewhat longer route swinging farther northward, might offer more favorable "pioneering" aspects. Such a route might run northwestward from Tanana through the subdued Ray Mountains, crossing the Koyukuk River near Hughes, thence westward over high ground past Hog River and southwestward to Haycock and Council. Cost of this route has been estimated roughly at $40 million.

The main benefit of this more northerly route is the traversing of somewhat more promising mineral land between Tanana and the Seward Peninsula; but, of even more importance, it would provide closer access to more favorable mineral country in the Brooks Range region lying to the north. It would come reasonably close to the important copper exploration activities at Kobuk, from which a fairly short access road could be built to tie into the road leading southwestward to Norton Sound if future developments are sufficiently encouraging. If a mine, concentrator, and possibly a smelter were developed and built near Kobuk, traffic in all probability would be from and to the west over a Council-Tanana road rather than east. If and when such a road is begun, there might be advantages in starting construction from Norton Sound eastward rather than from Eureka and Tanana westward, to provide a route for travel to and from Kobuk at an earlier date.

In planning any route from Haycock to Nome, consideration might well be given to running a branch road south to Golovin, a satisfactory harbor on Norton Sound, since costly lighterage of several miles is involved in loading and unloading vessels at Nome.

Types of Highways Best Suited to Area

Opinions differ widely as to the types of highways best suited to Northwest North America. This variance is not concerned principally with differences of views with respect to concrete versus asphalt for paving, for example, but between gravel and hard-surfaced roads. There is quite uniform preference for asphalt to cement for hard surfacing or paving.

The thinking of those who feel that gravel-surfaced roads are best suited to the Area is shared mainly by those whose prime interest is in the hauling of heavy loads. They stress the fact that they are actually operating over a hard-surfaced road for the greater part of the year, due to its frozen condition during the long winter season. Proponents of this theory tend to dismiss the presence of dust and added tire wear as being inconsequential, and generally wind up by admitting that they are afraid that more stringent load restrictions will be imposed once a highway is paved, particularly during the spring thaw. They rightfully claim that too rigid restrictions would materially increase the per-ton transportation cost of cargoes hauled over the highways. The solution of this problem is beyond the scope of this report, but the problem is one that should be given careful consideration by those charged with formulating a long-range highway construction or improvement program inasmuch as the transportation of mineral ores and concentrates over the highways <u>must</u> play a major role in the economic development of the region.

On the other hand, if full advantage is to be derived from "tourism", it is imperative that dust- and rock-free highway surfaces be provided in order to reap the tourist dollar harvest since those that would consider making the trip by auto have long since become accustomed to hard-surfaced highways.

Paving Types. Due to climatic conditions hot-mix asphaltic concrete pavement has been the predominant type of paving material used in the Area. This is readily understandable because in this particular type of mixture the ingredients are artificially heated before mixing, the mixture is applied to the roadway and compacted to the required density while hot. The process is completed when the mixture cools to atmospheric temperature, hence the weather problem is, to a great extent, circumvented by the use of this type of paving mixture. Any desired thickness from 3/4 inch upward can be laid; however, a 2-inch thickness has generally been employed in the Area, hence a like thickness was used by Brown & Root in preparing the cost estimates.

In recent years, in Alaska, penetration-type surfacing has been used on highways having low traffic densities and also on those lying within the permafrost zone. The sections so treated have not been in service long enough to permit of a full evaluation of its merits. This economical method of providing smooth, dust-free, riding surfaces deserves much more attention and study than it has apparently received. The potential savings in capital investment are large enough to warrant careful study and testing of this type of surface treatment.

The U. S. Bureau of Public Roads in Alaska adopted the policy of using this less costly type of surfacing in the permafrost areas. This also is recommended by the Northwest Highway Maintenance Establishment of the Canadian Army charged with maintaining the Alaska Highway. This thinking is predicated on the knowledge that regardless of the type of surfacing or pavement used, the riding surface will become so distorted in a few years, due to changing thermal conditions underneath, that reconstruction of the road is required. Therefore, large savings are made possible through this practice.

A peculiarity of asphalt is that the kneading action of vehicle tires passing over the surfacing is necessary for the asphalt to retain its resilience. With no traffic, or insufficient traffic to keep the asphalt "alive", it begins to harden and becomes brittle, myriad hair cracks appear on the surface, water enters these cracks, and the destructive process of complete disintegration is in full swing. Frost action helps to accelerate this action.

This disintegrating process can be retarded and the life of the pavement prolonged by the periodic application of a "seal coat". This consists of an application of heated liquid asphalt over the surface of the pavement and stone chips spread on the asphalt to provide traction. When the asphalt in the seal coat loses its "life" and begins to check, resealing again becomes necessary.

Penetration-type "surface treatments" are subject to the same processes and likewise can be periodically rejuvenated and their usefulness prolonged by seal coating.

Hence, with capital costs much lower and maintenance cost comparable, consideration should be given to the use of this type of construction on those parts of the highways having low-density traffic. When traffic density increases to a point that would justify the expenditure of funds for the higher type and costlier pavements, they could be applied on the same base.

In permafrost areas and on roadway fill sections over muskeg, the riding surface eventually becomes so rough that the only remedy is to destroy the surfacing or pavement, reconstruct, and reshape the surface. This procedure is economically justifiable with the use of the lighter, less costly surface treatments, but not so with costlier types of pavements.

Cost estimates for this less costly asphaltic-surface-treated type of highway were therefore included in the Brown & Root studies. Because traffic density will be quite light over the routes recommended for many years, Battelle favors the use of this type of highway over such routes, and cost-benefit considerations given in Chapter IX are based on this type of road.

Maintenance Costs – Gravel Versus Paved Highways

Because of its importance in appraising the cost side in a comparison of costs and benefits of hard-surfaced (paved) and gravel highways, Battelle requested Brown & Root to study this problem. Best sources for information on this are:

(1) Alaska Branch of the U. S. Bureau of Public Roads, Juneau, and

(2) Northwest Highway Maintenance Establishment, Royal Canadian Engineers, Whitehorse, Yukon Territory.

However, records have not been kept that would permit of a meaningful comparison without a lengthy, detailed investigation that was beyond the scope of this study. So-called maintenance work on the highways of the Area (especially in Canada) has included very substantial effort and costs in upgrading the roads – relocations, heavier bridges, improved drainage and subgrades, etc. Even more importantly, the amount of work done has necessarily been limited by funds made available, and these may well have been quite inadequate in the past – especially for the paved roads in Alaska. Hence, there may be serious question whether the quality of maintenance has been comparable in cost comparisons.

The Brown & Root report (Supplement I) discusses this entire problem in considerable detail. After an objective analysis of the various categories of maintenance costs (plant, administrative, supervision, equipment, and labor) involved in maintaining a primary gravel versus paved highway, they summarize and conclude as follows:

> "It must be borne in mind that maintaining the highway and keeping traffic moving over it during the winter months and spring breakup determines the basic minimum requirements for plant, equipment, and personnel below the administrative level. This period covers 6 to 7 months of the year, hence approximately half of the annual maintenance budget would rightfully be chargeable to snow removal, or winter maintenance. The remaining budgetary funds are expended during the summer months for what would be termed normal roadway maintenance, such as culvert

and bridge repairs, much of which is occasioned by the breaking up of the ice and the attendant flooding during the spring thaw; bridge painting; roadway ditch and offtake channel cleaning and dressing; slope dressing and slide control; the repair and replacement of roadside markers and warning signs; and in the case of a gravel-surfaced highway, repairing frost boil damage, blading the travel portion of the roadway to provide a reasonably smooth riding surface, and the periodic replacement of the gravel surfacing material which is lost through the erosive action of wind and water.

"In the case of a paved or hard-surfaced highway, operations on the travel portion would consist of repairing frost boil damage, shoulder maintenance, repairing breaks in the surface due to frost action or other causes, the periodic resealing of the asphalt surface by 'Seal Coating' (that is, the application of a light film of liquid asphalt covered with stone chips), and the application and maintenance of roadway center and warning stripes.

"The travel portion of a highway constitutes a minor part of the overall maintenance functions, and, in the absence of bonafide cost data, it is difficult to visualize any appreciable difference in maintaining this highway with a gravel surface or with a hard wearing surface. Therefore, any decision relative to paving, or not paving the Alaska highway, must perforce be based on indirect benefits rather than on any monetary savings derived from maintenance operations.

"In most instances per annum highway maintenance costs are the quotient of the available funds divided by the miles of road maintained. Rarely, if ever, are the allotted funds sufficient to achieve the optimum maintenance required to properly safeguard the capital investment. Since cost data do not necessarily reflect the true over-all cost of proper maintenance, it was necessary to determine the degree of maintenance which was achieved with the expenditure of known sums in order to project realistic estimates of cost for highway maintenance in the northwest. Analyses of local conditions and available cost data indicate an average annual expenditure of $2,500 per mile as a minimum figure to use for the maintenance of paved highways in the region. The same figure would be applicable to a gravel-surfaced road comparable to the existing Alaska highway."

Sites for Airfields

In choosing preferred locations for highway routes in this study, secondary consideration was given to proximity of suitable locations for airfields. Such consideration was advisable, of course, because of the continued growth in importance of the airplane in satisfying vital transport needs in such vast areas of undeveloped country.

It may be said, in a broad, general way, that satisfactory locations for modest-sized airfields capable of servicing types of airplanes visualized as suitable for use in the Area in the next 20 years, are available at reasonably spaced intervals over the routes chosen for recommendation. It was not felt necessary to carry such study so far as the pinpointing of specific locations.

Water Transportation

Battelle is in thorough agreement with the widespread conviction that improved passenger and freight service over the ocean waterways serving the Area are a vital necessity for its future healthy economic growth. This includes (1) the ferry service in Southeastern Alaska; (2) improved and extended barge freight service between Alaskan ports and Prince Rupert or U. S. ports in the Pacific Northwest; and (3) a possible ferry connection between Port Hardy on Vancouver Island and Stewart, Prince Rupert, and Kitimat.

However, as stated earlier in this report, these are considered to be in the "planned" stage, so that detailed studies leading to possible recommendations concerning these were considered unnecessary.

Rail Connections Between Fairbanks and the Canadian-U. S. Rail Network

The economic feasibility of a railroad connecting Alaska with the southern 48 states was given careful analysis. Aside from military and civil defense considerations, which were specifically excluded from the Battelle study, most present-day railroads must justify their existence almost solely as low cost carriers of large volumes of bulky or heavy freight over relatively long distances. Developments in highway and air transport in the past couple of decades have cut rail passenger travel severely, and have made substantial inroads on rail freight and express traffic. Railroad revenues in modern times are largely derived from freight operations.

The preceding resource analysis shows that potential freight traffic arising by 1980 from development of known inland resources in Northwest North America would be quite limited. In the event of future significant resource discoveries in inland locations, such as sizable mineral deposits of commercial grade, Battelle believes that transportation economics would favor shipment by way of highway or rail to the closest accessible port. This would allow cheap water shipment to overseas markets or to markets far to the south rather than by more costly long overland shipment. Such shipment to coastal points might be by highway or rail, depending on location of existing facilities with respect to the mineral deposit, and on types and quantities of materials involved.

In justification of this belief that any really large future freight shipments from and to central Yukon Territory, for example, would move to the coast and south by water to markets, one can only cite the fact that water shipment would comprise a large part of the total distance. It should also be emphasized that the great bulk of such freight would be ore or concentrates – possibly smelted or refined metal – plus smaller quantities of supplies needed in the mining operation and the mining community. The much lower costs of water shipment compared with rail are well known. Transfer and longshoring costs that are involved reduce the advantages of water; but progress is constantly being made in raising efficiencies of such transfers by improved mechanization. And labor unions are showing signs of a more reasonable attitude in dealing with these progressive developments.

Probably the outstanding example to cite in support of this conviction is the movement of iron ore from Lake Superior region mines to steel plants south of Lake Erie. Two extra transfers are involved in loading into and out of lake vessels, with rail hauls of a hundred miles or so at each end. Rates for movement of iron ore from the Mesabi Range of Minnesota to Pittsburgh are \$3.37 per gross ton (about 33 per cent) cheaper by Lakes shipment than by all-rail (\$6.75 via Lakes and \$10.12 via all-rail). The Lakes figure comprises the following elements:

	Rate per Gross Ton
Rail freight to Duluth	\$1.47
Railroad car to hold of vessel	.19
Lake freight, Duluth to Lake Erie port	2.00
Hold to rail of vessel at Lower Lake port	.28
Rail of vessel to railroad car	.19
Rail freight, Lake Erie port to Pittsburgh	2.62
	\$6.75

A similar comparison for shipments from the Marquette Range, Upper Michigan, to the Pittsburgh District shows a rail-lake-rail rate of \$6.22 compared with an all-rail rate of \$8.22.

As a result, all-rail shipments have comprised only around 2 million tons per year compared with, say, 60 to 85 million tons moved by combination rail-lakes systems. Probably most of the all-rail movement goes from Lake Superior ranges to the Chicago or Granite City, Illinois areas. Incidentally, the all-rail rates figure out at just about 1 cent per gross-ton-mile or about 0.9 cent per short-ton-mile. Rates for the Lake movement, including loading and unloading charges, amount to about 1/3 cent per ton mile for an average haul of about 850 miles from Duluth to Lower Lake ports.

Increasing barge traffic on the Mississippi and Ohio Rivers might be cited as a further example of savings in transportation by water compared with rail. By and large, water rates where available in competition with rail tend to hold rail rates down, rather than the converse. In support of this statement, the following quotation from a recent U. S. government publication(2) is pertinent:

> "Large increases in commercial cargo movements on inland waterways during the next 20 years are in prospect. Current charges for inland water transportation now average about 4 mills per ton-mile, in contrast to 16 mills per ton-mile charged by rail. Low-cost service is attracting more and more tonnage to the river systems. From 1948 to 1958 traffic on the waterways increased at the average rate of 7.5 million tons annually . . . The industry handled 366 million tons in 1958 and envisions the movement of 717 millions tons [annually] within the next 20 years."

Shipments to Japan, an important potential customer of raw materials from the Area, would certainly move to tidewater by closest feasible route and method.

The Wenner-Gren British Columbia Development Company, Limited, has been under agreement with the Government of British Columbia for the past several years to conduct a survey of resource development. This company agreed, among other things, to survey a route for a railroad across northern British Columbia and to begin construction of this facility not later than June 30, 1960. The survey was completed in December, 1959, by Colonel Sidney H. Bingham, Ret., Consulting Engineer of New York, and his associate, Mr. H. H. Minshall of Vancouver, British Columbia.

Results of the location and cost study made by Colonel Bingham for the Wenner-Gren Company were made available to the Commission in July, 1960, and Battelle received a copy of the report(3) from the Commission in August. Location of the proposed routing northwestward from Summit Lake (north of Prince George on the Pacific Great Eastern Railway) to the Yukon Territory boundary north of Gladys Lake is shown in Figure VII-1. Among other matters, the report covers route descriptions, construction schedule and planning, and a construction cost summary. Important aspects of the railroad covered in the Bingham report are summarized as follows.

The Pacific Northern Railway, incorporated in early 1960, would begin at about Mile 31 north of Prince George on the PGE, adjacent to Summit Lake. The route selected runs northwesterly along the eastern shoreline of Stuart, Trembleur and Takla Lakes, the western shore of Bear Lake, through the valleys of the Sustut River and the Skeena River and its tributaries to Damdochax Lake; thence along the east side of the Nass River to its headwaters at the Summit, down the Klappen River and across the Stikine River, continuing northwestward along the Tuya River and Teslin River past Teslin Lake, and along the north shore of Gladys Lake to reach the Yukon-British Columbia boundary about 10 miles east of the head of Atlin Lake. This point is some 80 miles southeast of Whitehorse, Yukon Territory, the northern terminus of the White Pass & Yukon Route connecting Whitehorse with tidewater at Skagway, Alaska.

An alternative route at the south end, originating at Hazelton, British Columbia, on the Canadian National Railway, following the Skeena River northward to join the previously described route south of Damdochax Lake, was given some attention. Because the route to Summit Lake appeared feasible and was preferred by British Columbia officials, no further consideration was given in the Bingham survey to the route starting from Hazelton.

Consideration of the Trench Route – the old "B Route" surveyed by the U. S. Army Corps of Engineers in 1942, extending northwestward from Anzac (about 70 miles north of Prince George on the PGE) along the Parsnip, Finlay, and Kechika Rivers to Watson Lake on the Alaska Highway – was excluded by Bingham. It was not considered because if the dam proposed by the Peace River Power Development Company Limited is built, some 200 miles of the "Trench Route" would be flooded. Sidehill location of a railroad along the route above the lake level was considered impractical.

The Bingham report on the Summit Lake-Gladys Lake route – now the planned Pacific Northern Railway – envisioned a railway meeting standards for Class A operation, with a maximum grade of 1.75 per cent and maximum curvature of 12 degrees. As located, there is only one controlling grade of 1.70 per cent on both sides of Gnat Summit north of the Stikine River crossing, with all other grades no greater than 1 per cent. Except for two 10-degree curves, the maximum curvature is 8 degrees, with 87 per cent at 6 degrees or under. The roadbed up to subgrade was designed for Class A operation in accordance with the most recent Canadian practice for this type of country, particularly in relation to drainage and snow removal. Bridge and trestle designs would be those of the Canadian Standards Association, planned in accordance with Cooper's E-60 loading.

A few other specifications which indicate the type of railroad envisioned in the Bingham report include 100-pound mainline rail in 39-foot lengths, 3200 ties per mile (untreated from local timber), selected pit-run gravel obtained locally for ballast, and rail anchors averaging 2200 per mile. Passing sidings, each with a capacity of 100 cars, would be located at an average of 27 miles apart. Plans include 7 combination passenger-freight stations and a major freight station at both the north and south terminals, plus necessary buildings for crew and staff accomodations, and for railway maintenance and repair at appropriate points. Sidings and yard tracks would be 85-pound rail. A classification yard at the south terminal would be capable of handling 2000 cars daily with all modern facilities for automatic classification. Communications along the route would be by a microwave system.

Total cost of the Pacific Northern Railway, as estimated in the Bingham report, is $250,990,000 based on December, 1959, cost levels, but not including engineering costs or working capital. It does include some $9,000,000 for rolling stock needed for construction which could later be used for operation. For a 697-mile main line this amounts to an average cost of $360,000 per mile. Included in the above total are the following construction costs:

Southern terminal (including classification yard for 2,000 cars with automatic controls)	$4,905,000
Northern terminal	1,795,000
Divisional and 2 subdivisional headquarters	3,480,000
Signals and communications	17,000,000

This cost-per-mile figure is comparable with that for the Quebec North Shore and Labrador Railroad completed several years ago in eastern Quebec, which runs from Sept Iles to the iron mines at Schefferville (Knob Lake). Including some equipment, this line was reported to have cost $125,000,000, which, for the 355-mile main line, would average $350,000 per mile. Terrain is roughly comparable. It has also been learned that similar per-mile costs have been experienced by Quebec Cartier Mining Company in their 193-mile main line in eastern Quebec running from Port Cartier on the St. Lawrence north to Gagnon at the Lac Jeannine iron ore deposit. Both these lines were built to top standards, of course, since they must handle very heavy iron ore traffic — many millions of tons annually.

The British Columbia Government and the Wenner-Gren interests have made surveys of the potential resources of northern British Columbia and have presumably made studies of the economic feasibility of the PNR, although no discussion of the latter was contained in the Bingham report seen by Battelle. The excellent timber resources along the southern portion of the route would provide substantial freight from that section. No attempt has been made by Battelle, however, to relate the construction and operating costs of the PNR to the benefits that might accrue to British Columbia and Canada, because the PNR is considered a planned project under the jurisdiction of British Columbia.

Whitehorse-Fairbanks Rail Facility

As discussed previously, a rail facility connecting central Alaska with the Canadian-U. S. rail network might have desirable features and has been the subject of several studies during the past 20 years. With the PNR considered as a planned facility, there remains for analysis the economic feasibility (costs compared with benefits) of a railroad joining the north end of the PNR with central Alaska. Since the Alaska Railroad has a spur running some 25 miles southeast from Fairbanks to Eilson Air Force Base, this will be considered the closest junction with rail in the Fairbanks area representing central Alaska. If the PNR is constructed northward in stages related to future traffic needs along the line (as indicated in discussions with Wenner-Gren and British Columbia officials), it might be many years before it reaches the vicinity of Whitehorse.

Whitehorse is the terminal of the White Pass and Yukon Railway (narrow gauge) leading to the closest tidewater port at Skagway. As mentioned earlier, Battelle's study has indicated that transportation economics would probably favor movement of any large quantities of freight (ores, concentrates, and supplies used in mine operations) from interior points by shortest feasible route to tidewater, and thence by water shipment to markets to the south or overseas. Any resource developments involving Japanese interests and markets – probably a major factor in economic growth of the area in the next 20 years – will certainly move most directly to suitable harbors on tidewater.

In spite of these apparent limitations, consideration is therefore given to a railroad between Whitehorse, Y.T., and the closest junction in central Alaska at Eilson Air Force Base. There are two major routes from which to choose: (1) a route up the location of the Alaska Highway, and (2) a route northward near the Mayo Road to Carmacks, thence following the route surveyed by the U. S. Army Corps of Engineers in 1942 down the Yukon past Fort Selkirk to the mouth of the White River (about 15 miles south of the mouth of the Stewart River), thence westward up the White and Ladue Rivers to join the Alaska Highway just east of Tetlin Junction (about 20 miles east of Tok Junction). Location of this route can be followed by rivers and places identified on Figure VII-1.

Comparison of mileage between Whitehorse and Tetlin Junction by the two routes, including an additional 10 per cent over highway mileage to cover railroad development to meet maximum allowable grades, shows the Carmacks, White River and Ladue River route to be some 40 miles shorter. Moreover, the Canadian Government is known to favor this route since it would traverse country between Fort Selkirk and Tetlin Junction not served by road at present. For these reasons the route via Carmacks-White River-Ladue River was studied. The extensive 1942 survey by the U. S. Army Corps of

Engineers(4) was helpful in giving detailed location, distances, and gradients on a map with profiles, together with text describing the route and type of railroad considered. Another unpublished document(5), by the U. S. Department of the Interior – prepared as a working paper for use by the Negotiating Committee in furtherance of Public Law 391, 81st Congress, 1949, authorizing a joint survey with Canada for a Prince George-Fairbanks railroad – has been helpful in summarizing past thinking on this general subject.

Standards governing the 1942 survey and subsequent design were based on the requirements for a military railroad with speed of construction given first consideration. Limiting grades along the route between Carmacks and Eilson would be 1.5 per cent, and maximum curvature 15 degrees. Lightweight rail of 60 (later changed to 80) pounds per yard was planned to effect savings in wartime critical material and ease and speed of placement. Sidings 1/2 mile in length were planned at approximate 10-mile intervals. Design considerations included maximum speed of 35 miles per hour.

Estimated distance for the route from Whitehorse to Eilson is about 590 miles. This was arrived at by estimating distances from Whitehorse to about 20 miles north of Carmacks; using mileages on the railroad survey map made by the Corps of Engineers from north of Carmacks (Mile 932) to Mile 1340 (about 30 miles west of Big Delta, Alaska); and estimating mileage from there to Eilson AFB.

Construction costs would certainly be lower than those estimated for the PNR in the Bingham report. Terrain is much easier, but permafrost problems are added. Bridge crossings of the White River and two over the Tanana River are not difficult, and the many crossings of the Ladue River are small. Standards assumed are comparable with those of the recent PGE extension between Prince George and Fort St. John-Dawson Creek, including 85-pound rail. Construction costs are assumed to be considerably higher in the Yukon-Alaska area because of (1) higher costs of moving materials to construction sites, (2) substantially higher wage costs, and (3) moderate general cost increases during the several years since the PGE extension was built. It is roughly estimated that total construction costs per mile would be 40 per cent higher than the $180,000 per mile experienced by the PGE, or, say, $250,000 per mile. For the 590 miles of railroad between Whitehorse and Eilson this would amount to a total of $147.5 million.

Assuming interest charges of 5 per cent and amortization over a 50-year period, annual charges for capital recovery would be: $147,500,000 x 0.05478 = $8,080,050.

Annual operating costs, including maintenance, are estimated at $15,000 per mile, a total of $8,850,000. This is a higher figure than the PGE operating costs for 1959 that averaged $11,400 per mile of main line, but considerably less than the Alaska Railroad, which averaged some $20,000 per mile of main line (excluding longshoring and depreciation charges shown in their annual report, but including general and administrative expenses) for the year ending June 30, 1960. Through strict economies, including operation as a part of the Alaska Railroad, the annual operating costs might be lowered by 50 per cent or more, estimated by the Alaska Railroad as low as $7,000 per mile. Relatively low traffic volume visualized would contribute to lower operating expenses, although maintenance of close to daily train schedules would limit the amount of cost reduction from lower traffic.

At the $15,000 per mile operating cost figure, total annual charges would come to $16.9 million. Subtracting a liberal estimate of $400,000 for revenue from passenger traffic (10,000,000 passenger miles at 4 cents per passenger mile) leaves about $16.5 million per year to be met by revenue from freight traffic. The following tabulation shows annual tonnages of freight haul necessary to provide $16.5 million annual revenue for average distances of haul shown:

Average Length of Haul (Miles)	Annual Freight Haul, Millions of Tons, for Average Ton-Mile Revenue Indicated				
	$.02	$.03	$.04	$.05	$.06
400	2.06	1.37	1.03	.82	.69
300	2.75	1.83	1.37	1.10	.92
200	4.12	2.75	2.06	1.65	1.37

What is a reasonable foreseeable figure for freight movement over the Fairbanks-Whitehorse-Skagway route in the next 20 years? Any estimate is dependent, in part, on whether or not the White Pass and Yukon Railway is converted from narrow to standard gauge. It is known that White Pass officials have given serious study to this, but there is now no real reason to make the change — especially since officials state that tonnage over the present line can be tripled with only minor additional capital costs. But to make the haul from central or eastern Alaska or from central Yukon at all attractive over a new line, conversion of the White Pass to standard gauge would be desirable. Even so, the likelihood of sufficient freight traffic to pay operating costs, interest, and amortization of the Whitehorse-Eilson line appears remote, based on probable developments from known resource occurrences, as shown by the following brief discussion.

The Fairbanks area generates a total of some 55,000 tons per year of dry cargo (excluding movement of coal from Healy) — an estimated 15,000 tons northbound on the railroad, 15,000 tons northbound by truck from Valdez, 15,000 tons total southbound over rail and highway, and 10,000 tons in and out over the Alaska Highway. Certainly little of this limited tonnage would take a 700-mile route to tidewater at Skagway compared with the much shorter hauls to Anchorage, Seward, or Valdez, if the White Pass were not standard gauged. If it were converted to standard gauge and railroad-car-barge service south of Skagway permitted roll-on and roll-off transfers, some Fairbanks traffic might be visualized. However, it is believed that future combination land-water transport economies lie in improved transport by use of containers, including efficient transfer equipment and systems, thus avoiding the heavy excess weight of complete railroad cars, vans, or trailers. Ultimate completion of the highway from Anchorage to Fairbanks, now being programmed by the Alaska Highway Department, will further encourage freight movement by truck between these two cities.

Similarly, distances from the Big Delta area are much shorter to Valdez (by truck) than by rail to Skagway (273 miles to Valdez versus 625 miles to Skagway). Most of any possible future tonnages to or from the Tok Junction area (very small at present) also would probably move most economically by truck over the much shorter route to Valdez (257 miles to Valdez compared with 512 miles to Skagway).

The above analysis of probable traffic movement assumes that rail rates would be established at levels that would at least come reasonably close to paying all railroad costs — amortization, interest, and operations.

Best potentials for development of moderate tonnage freight movements would be from the central Yukon area centering around the Keno Mill mining district. Present annual tonnage out of and into the area is around 50,000 tons. Additional mining developments in the next 20 years could well see this tonnage doubled, especially if the price of silver rises. But this tonnage, surely not enough to warrant a spur line and bridge to the closest point on the contemplated Whitehorse-Eilson railroad across the Yukon River from Minto, would still move 175 miles by truck to and from Carmacks. Unless the White Pass were standard-gauged, it appears doubtful that this tonnage would be dropped near Minto for a rail haul of some 140 miles to Whitehorse and be subject to another transfer handling at that point onto the narrow-gauge White Pass Line.

Presence of the railroad might possibly spark development of the zinc-lead-copper deposit at Vangorda Creek during the next 20 years. This deposit is about 125 miles (by potential truck or diesel-truck-train trail) east of Carmacks, and its development could generate outbound annual tonnages of, say, 70,000 tons of concentrates and inbound tonnages of around 30,000 tons.

Additional mine developments from known ore occurrences around the Tinta Mountain area west of Carmacks might develop, say, 25,000 tons of freight annually in the next 20 years.

Freight into and out of Dawson City is minor, with prospects of further reductions from lessened gold dredging operations unless the price of gold is raised. Oil developments in the Yukon over the next 20 years could result in annual inbound freight movements of several thousand tons, and opening of the Clinton Creek asbestos deposit near Dawson might generate a total of 50,000 tons annually.

All in all, judging from known resource occurrences, Battelle is unable to visualize more than around 300,000 tons annually of freight in the area that would be served by the standard gauge railroad, moving an average distance of, say, 200 miles to or from Whitehorse. With truck competition holding rates to around 5 cents per ton mile (present costs of efficient large scale trucking of minerals and supplies), revenues from this movement would amount to about $3 million – short by $13.5 million of meeting annual freight revenue needed for break-even operation. If operations cost were reduced to, say, $7,000 per mile, the above annual revenues would be short by about $8.8 million of break-even operation, or to $0.7 million if amortization and interest charges were omitted.

It should be emphasized that the great bulk of the 300,000 tons mentioned above would be ore or concentrates plus supplies needed in the mining and milling operations and in the mining community. This is the type of freighting operation that would be handled by a contract carrier – not by a common carrier. For this reason, the rate of about 5 cents per ton mile is quoted, since this is the per-ton-mile cost of the truck movement of concentrates from the United Keno Hill and Cassiar operations(6)(7). Moreover, this applies all costs to the one-way outbound freight movement alone with no credit for ton-miles back-hauled. Gritzuk has reported* that if this were included, the ton-mile costs would reduce to around 3 cents. It might also be mentioned that Chairman Manning of the Royal Commission on the Great Slave Lake Railway, in expressing his doubt as to the need for the railway, stated that concentrates could be

*Personal communication.

trucked from Pine Point to Grimshaw (some 430 miles) over the Mackenzie Highway for 4 to 4.5 cents per ton mile.(8)

Indirect benefits might be added as follows: (1) taxes from railroad employees' income and from service industries and employees generated by railroad employees, (2) taxes from expenditures made in Alaska and Canada by tourists traveling over the railroad, (3) possible rental of right-of-way for pipelines or power lines (this seems remote) and of communications systems, and (4) taxes from increased land values and industries generated by the presence of a railroad. Some of these involve only minor benefits, while others would include such highly conjectural factors as to preclude reaching meaningful estimates.

Some students of railroad economics may question the fairness of including amortization and even interest charges in evaluating the economic feasibility of a railroad that would be government owned. The Alaska Railroad, for example, has never been required by the U. S. government to include interest charges, and only recently did it set up a reserve for depreciation. Under these conditions, of course, annual operations would require that much less revenue to break even or show a profit, as cited above. These costs, however – and they are real costs – must then be borne by the government, and ultimately by the public via taxes. Some students might consider these subsidies as being balanced in the long run by many of the indirect benefits listed in the preceding paragraph, plus the broad cliché of "opening up the country". This may well be true <u>if</u> these hidden values develop sufficiently. But until they are proved, the public should understand that the operation is being subsidized to the extent that such indirect benefits do not measure up to the amortization and interest charges conventionally applied to business operations. Major comparable government projects, such as hydro-electric developments and the St. Lawrence Seaway, for example, are expected to "pay out" over a reasonable period, including amortization and interest.

A railroad of this type might also be financed by another form of public subsidy, in which promoters would receive from the government extensive land grants along the route, the increased value of which may eventually repay the huge risk investment with interest. In such event, a fair and factual statement should be given to potential investors concerning the nature and extent of the risk involved, as required by many governmental regulations for issue of securities.

A few final comments are appropriate concerning the relative value of a pioneering railroad versus highways in "opening up the country". In the days of construction of the transcontinental railroads late in the 19th century, when only alternatives were ox-drawn prairie schooners over rough trails or windjammers around the Horn, the tremendous value of a pioneering railroad through potentially rich country is well recognized. A century of progress in transportation has radically changed this picture, with truck, fast vessel, barge, and the airplane moving more and more freight ever faster and more efficiently. Further improvements may be expected including developments such as hydrofoils over water and air cushion vehicles over land or water. With costs of efficient trucking of regularly scheduled moderate tonnages of minerals and supplies over highways in the far north down to 5 cents or less per ton-mile, there is serious doubt whether a pioneering railroad is more effective in "opening up the country" than a reasonably good highway. Average ton-mile costs for such a pioneering railroad will surely equal or exceed this figure. If probable tonnages are really large – upwards of many hundreds of thousands or millions of tons annually – there is undoubtedly real justification for a railroad. Railroads recently constructed or planned to known sources of such large tonnage hauls in Canada are the lines to vast iron ore deposits in eastern Quebec, the lines to copper and zinc deposits of Chibougamau and Mattagami in Quebec, and to the vast zinc deposits at Pine Point, NWT.

For pioneering purposes in "opening up a country" with resources yet unproved, a preferred sequence would appear to involve systems of pioneering roads to spur mineral exploration and settling, followed by improved highways as needed, and later by railroads *if* proved large tonnages justify the high cost. Highways serve the double purpose of providing means for moving moderate freight tonnages efficiently by truck and moving more and more vacationing people by automobile to attractive wilderness areas.

As a result of the above analysis, Battelle did not see justification for a detailed engineering study to be made of the preferred location and cost of a railroad linking central Alaska with the Canadian-U. S. rail network, or tie this in with a more detailed study of benefits. It should be reiterated that defense considerations – military or civil – were *not* included in this appraisal of benefits of a Whitehorse-Eilson railroad. This general discussion of railroad costs versus benefits will not be repeated or summarized in Chapter IX, which will be concerned only with an integrated highway system.

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(3) Bingham, Colonel S. H. (Retired), "Report on Route and General Plan for a Railway in British Columbia, for the Wenner-Gren British Columbia Development Co. Ltd." (December 15, 1959).

(4) War Department, United States Engineer Office, "Report on Survey Trans-Canadian Alaska Railway Location," October 12, 1942, unpublished manuscript, including maps.

(5) U. S. Dept. of the Interior, Office of the Secretary, "Trans-Canadian Railroad to Alaska – A Preliminary Review," undated mineographed manuscript prepared probably in 1950.

(6) Gritzuk, N., The Role of Transportation in Developing the New Northwest, Western Miner and Oil Review, April 1959.

(7) Gritzuk, N., Diesel Truck Transport in the Yukon, paper presented to the SAE 1959 International West Coast Meeting, Vancouver, B. C., August 12, 1959

(8) Report of the Royal Commission on the Great Slave Lake Railway, June 1960, Vol. 1, page 12.

IX. COMPARISON OF COSTS AND BENEFITS OF IMPROVED TRANSPORT FACILITIES

A review of the transportation needs of Northwest North America to encourage the rapid and orderly development of its known resources makes it obvious that the primary requirements for improved interregional transportation in addition to those projects presently planned or under active development are (1) to stimulate the movement of people to and from the Region and (2) to provide better and alternative means of communication for inhabitants of the Region. The movement of needed materials to encourage the development of known natural resources and the movement of the products made or recovered from these natural resources would virtually all use either existing and planned transport facilities or would require only the development of intraregional access roads to permit their movement to tidewater. Such access roads are, of course, vital to the long-range economic development of the Region. Examples of such access roads have been given in this study, but detailed investigation of the need for intraregional transportation per se is beyond the scope of this study.

Discussion of tourism needs in Chapter V pointed out severe limitations of present surface transportation as a mechanism for attracting really large numbers of motorists to the Region. Using these components as a base, however, it was possible to evolve a complete system that would have the necessary flexibility and convenience to attract by 1980 an estimated 370,000 highway passengers from outside the Region to Alaska, and an estimated 350,000 additional highway passengers from outside the Region to Canadian destinations.

The major components of this integrated system are the Alaska Highway and a new highway (Route 5) from Hazelton, British Columbia, to Jakes Corner, Yukon Territory. Both of these highways, to be attractive, would need to be upgraded to provide a paved surface suited to high-speed travel of the modern passenger car. The needed flexibility of the completed system would be obtained through feeder routes from Route 5 to the Petersburg-Wrangell area and to the Juneau area, through improvements of the Haines Cutoff to make all year travel more practical, and through installation of the planned Southeast Alaska and Port Hardy ferry services.

Distance to the Alaska border via the Alaska Highway from Edmonton and points south and east would be about 225 miles shorter than using a route via Dawson Creek to Hazelton and Route 5 north to the Alaska Highway at Jakes Corner. When the Canadians construct the section of Highway 16 between Prince George and McBride, B. C., a route from Calgary using Highway 1 to Lake Louise, Alberta, and Route 93 from Lake Louise to Jasper, Alberta, connecting with Highway 16 at that point, would be about 100 miles shorter to the Alaska border via Whitehorse than the present route through Edmonton to Dawson Creek. On the other hand, the Alberta Government is planning a more direct route from Calgary to Grande Prairie and Dawson Creek, which would shorten the present route considerably. This latter route would lie East of the Rockies and would permit much faster travel than would be possible using the scenic route from Lake Louise to Jasper and Prince George. Certainly, having both routes would add to the flexibility of the system, and thus encourage more travelers to visit points in Alaska, Northern B. C., and the Yukon Territory.

Cost of the Integrated System

Detailed cost studies of these various suggested highway constructions and improvements have been made for Battelle by Brown & Root, Inc., except where noted. The cost summaries are shown in Table IX-1. Detailed cost estimates for these and other routes studied are given in Supplement I.

TABLE IX-1. CAPITAL COST OF INTEGRATED HIGHWAY SYSTEM
(Millions of Dollars)

Alaska Highway - Charlie Lake to Alaska border Upgrading and asphalt surface treating	(1169 miles)	101.3[(a)]
Route 5 - Hazelton, B. C., to Jakes Corner, Y. T. Construction of new sections, upgrading sections of existing roads and asphalt surface treating	(548 miles)	60.2
Petersburg Highway - Popof Creek, Alaska, to Junction Route 5, B. C. Construction and asphalt surface treating [20.1 (Canada), 3.7 (U. S.)]	(96 miles)	23.8
Juneau Road -	(123 miles)	
Route 5 to Alaska border - Construction and asphalt surface treating		17.6
Alaska border to Juneau - Gravel surface plus ferry across Taku Inlet		20.0[(b)]
Haines Cutoff - Mile 23.3 to Junction Alaska Highway Relocation of 40-mile section plus asphalt surface treat [12.8 (Canada), 3.7 (U. S.)]	(120 miles)	16.5
TOTAL [212 (Canada), 27.4 (U. S.)]		239.4

(a) Brown & Root estimates that cost of a bridge replacement between Charlie Lake and Ft. St. John would amount to an additional $1 million. On the other hand, the Alaska Highway was paved for about 30 miles north of Charlie Lake during 1960, which would reduce the estimated cost shown.

(b) Based on preliminary estimates made by Alaska Highway Department.

Assuming a 20-year life of the highway system for amortization purposes, the annual cost for recovery of capital investment would be $19.2 million at 5 per cent interest rate (capital recovery factor of 0.08024) or $17.6 million at 4 per cent interest rate (capital recovery factor of 0.07358). Annual maintenance costs for the 1969 miles in Canada at an assumed rate of $2500 per mile would amount to $4.9 million. Annual maintenance costs for the 85 miles in Alaska would amount to about $0.2 million, making a total annual cost for the system of $22.7 million to $24.3 million.

Reasons for not having made detailed cost studies for a central British Columbia-Fairbanks railroad or for other highway and road routes (both international and intra-Alaska) were given in Chapter VIII. The vital importance of including an expanding program of secondary pioneering roads in the Alaska state highway planning program was also pointed out. The equally important ferry service in Southeastern Alaska and expanded freight-barge service to Southeastern Alaska and the Cook Inlet-Kenai area – both considered in the planned category – were endorsed as aids to Alaska's economic growth.

Tangible Benefits of the Integrated System

Tangible benefits to the Alaskan economy from the development of the integrated highway system would be derived from the travelers' expenditures, which are estimated to be as follows by 1980:

Travelers on highways only – 370,000 x 17 days in Alaska x $20/day	=	$125.8 million per year
Travelers using highways and SE Alaska ferry – 45,000 x 17 days in Alaska x $20/day	=	15.3 million per year
Travelers using highways and Canadian ferry – 15,000 x 17 days in Alaska x $20 day	=	5.1 million per year
Total Expenditures		$146.2 million per year

Based on the assumption that operation of the ferry systems will be self-sustaining through fares charged to the users, both intraregional and interregional, benefits to be derived in the Region's economy from interregional users have been credited to the integrated system. It is recognized, of course, that some portion of the 60,000 interregional ferry travelers would utilize the ferry systems prior to or in the absence of development of the integrated highway system.

Tangible benefits to the Canadian Region's economy from the development of the integrated highway system which would be derived from traveler's expenditures are estimated to be as follows by 1980:

Highway travelers to Alaska 370,000 x 8 days in Canadian parts of the Region x $20/day	=	$59.2 million per year
Highway travelers using SE Alaska ferry to Alaska, 45,000 x 2 days in Canadian parts of the Region x $20/day	=	1.8 million per year
Highway travelers using Canadian ferry to Alaska, 15,000 x 2 days in Canadian parts of the Region x $20/day	=	.6 million per year

Highway travelers to Canadian destinations 350,000 x 10 days in Canadian parts of the Region x $20/day	=	70.0 million per year
Total Expenditures		$131.6 million per year

Tangible annual benefits by 1980 to the total Region from expenditures of "outside" travelers over the integrated system are thus estimated to be almost $280 million, distributed 53 per cent to the Alaska economy and 47 per cent to the Canadian economy. Excluding tangible benefits from the ferry operations to the integrated system would indicate 49 per cent of the benefits to the Alaska economy and 51 per cent to the Canadian economy.

Intangible Benefits of the Integrated System

Many of the benefits to the traveler involve gains that are quite intangible and immeasureable, such as (1) comfort and safety to travelers, (2) lower auto travel costs from reduced tire and under-car wear and lessened glass breakage, (3) time saved enroute, (4) pleasures and freedom of land access by automobile compared with access only by air, and (5) improved access to forest areas and to probable mineral-bearing lands requiring intensive exploration to assess their true potentialities.

Other intangible benefits from various portions of the integrated system would vary and may be cited to indicate further why the system as such has been selected.

Alaska Highway

Paving of the Alaska Highway would provide a shorter, faster route to Edmonton and to all points south and east. Past records indicate that 60 per cent of the highway travelers to Alaska have been from east of the Rocky Mountains, so upgrading the route might add significantly to the time this group can spend in the Region. Freight movements by truck might also be increased, with more frequent service and eventually lower rates.

Route 5 – Hazelton to Jakes Corner

Construction of the Hazelton-Jakes Corner route (Route 5) would provide a much shorter, more scenic route to Alaska from areas west of the Rocky Mountains. Development of this route would make favorable areas for metal and mineral occurrence in northwestern British Columbia more accessible for prospecting and exploration (see Figure V-10). Discovery and development of even one sizable mining operation would add many millions of dollars annually to the economic gains already cited. The shorter route from Seattle and other West Coast points would also encourage the movement of freight and express by truck with potential savings to the user.

Stikine-Iskut River Highway

Assuming completion of the ferry service in Southeastern Alaska, there is little doubt that construction of the Stikine-Iskut outlet would generate considerable tourist travel by auto, making a short circle route from Pacific Coast population centers over the Hazelton-Iskut-Stikine route to Petersburg and ferry service to Wrangell, Ketchikan, and Prince Rupert and returning via highway to Prince George and points to the south, or return via the Port Hardy ferry. Or these routes could be reversed.

Residents in the Wrangell-Petersburg area would enjoy the greater freedom of direct access to mainland areas east and south via auto without the expense of a lengthy ferry trip to Prince Rupert. Shipment of frozen or refrigerated fresh fish from the Petersburg area via truck to large markets in the Midwest, with return cargos of refrigerated foods or simply general freight or express, might develop and be of benefit to fisheries or cold-storage business through the opportunity of dealing more directly with consumers. Improved, year-around access to deep water via this route might well spur further exploration and development of numerous promising copper deposits in the Stikine-Scud River area. The Scud River area would still require some 60 miles of access road up the Stikine and Scud Rivers, but accessibility down the lower Stikine over a good highway to a deep-water terminal might well provide the needed impetus to perform more work on these promising areas. Development of two copper mines in this general area is projected as a possibility, with annual total output of some 216,000 tons of concentrates valued at around $32 million.

This road might also aid substantially in the development of valuable timber resources in the Stikine and Iskut River Valleys (see Figure V-17).

Haines Cutoff Relocation and Improvement

Cost of the 40-mile relocation plus upgrading and asphalt surface treating the Haines Cutoff highway from Mile Post 23.3 to Haines Junction is estimated at $16.5 million. Summer maintenance charges would actually be reduced, since the entire route would be shortened some 16 miles by the relocation. However, total maintenance costs would be increased by the costs of keeping the highway open during 6 months from November to May, which would be necessary for the system to be fully effective. The major reason for the relocation is to facilitate snow-removal by locating the road along the side of the Kelsall River valley (with room for dumping the snow) rather than in the bottom of a steep-walled valley (where there is no room for snow dumping), in its present location. Estimated annual costs for maintenance of the new highway are about $350,000. Past costs for maintaining the Canadian segment for 6 months and the U. S. segment for 12 months have not been estimated. Moreover, it is impossible to make an intelligent estimate of how much would be saved in year-round maintenance by the relocation compared with that over the old route.

Establishment of year-round ferry service from Prince Rupert to Haines would virtually require that the Haines Cutoff be kept open over the same period. But there are strong arguments for keeping it open regardless of this development. Substantial freight traffic of lumber, oil, oil products, and general cargo could be moved continuously, avoiding the present necessity of stocking substantial amounts in Yukon Territory over the long winter period. True, shipments may be made over the White Pass Railway, but this involves additional handling, water transfer, etc. Also, there is considerable interest in the possibility of developing several mineral prospects in Southwestern Yukon – (1) nickel-copper-cobalt-platinum from Quill Creek, (2) nickel from Canalask, and (3) copper from Johobo. A year-round open highway would be necessary for most direct truck shipments of concentrates to Haines from these three potential operations, that might total around 20,000 tons per year worth probably between $5 and $10 million.

Lacking any specific dollar benefits to cite, the strong conviction is held that year-round access by auto and truck to such a nearby ice-free port would pay off in many and varied benefits to the Yukon economy.

Taku River Road

Estimated cost of a 71-mile gravel road from the British Columbia boundary on the Taku River to a junction with the proposed Hazelton-Jakes Corner highway just south of Atlin is $12.6 million. Costs of asphalt-surface treatment for this section would be about $5 million additional. Estimated cost of the Alaska segment of the road from Juneau to the British Columbia boundary, made by Alaska highway officials, is about $20 million. The Alaska figure includes cost of a ferry and facilities for crossing Taku Inlet.

Benefits of this road revolve mainly around the intangible value of providing access to Juneau by auto and truck transport – of considerable importance for residents of Juneau and other parts of Alaska. Tourists would also be attracted to the route to visit Juneau and possibly circle around by ferry to the Petersburg-Stikine route, to Prince Rupert, or to Haines.

The provision of an all-weather road down the Taku River might influence the economics sufficiently to justify reopening of the Tulsequah Chief zinc mine just east of the British Columbia boundary. This could result in annual output of some 30,000 tons of concentrates having a value of around $5 million. However, opening of the Pine Point deposit by Consolidated Mining and Smelting Company – a probability in a few years – might postpone for some time the reopening of Tulsequah Chief, owned by the same company.

Finally, this new road would assist in the development of valuable timber resources along the lower stretches of the Taku River valley (see Figure V-17).

Qualifying Requirements

Projections of increased tourist travel, from which the foregoing benefits have been estimated, have assumed that other improvements to attract tourists will be made, such as (1) new and improved camp sites and motel accommodations enroute and within travel target areas, (2) improved service to travelers, and (3) greatly improved promotional activities and recreational facilities. If progress in effectuating any of these is unsatisfactory, the projections for highway travelers given in this report in all probability will not be realized, and benefits to be gained from the improved transport facilities will be lessened.

Cost-Benefit Comparisons

Tangible benefits that may be derived from use of the integrated highway system by travelers from outside the Region amounting to expenditures of $280 million annually by 1980 compare favorably with capital costs estimated at about $240 million for a system designed to encourage the economic development of a large and sparsely settled region such as Northwest North America. A comparison of the number of travelers estimated to use the system, 370,000 highway plus 60,000 ferry-highway to Alaska plus 350,000 to Canadian destinations, with annual costs of amortizing and maintaining the roads ($24 million at 5 per cent interest on capital investment) makes it obvious that the traffic is only a minor fraction of what would be needed to support the development of the highway system as a toll-road system, possibly in the range of only 10 to 20 per cent of the minimum requirements.

On the other hand, if so strict a criterion were used to justify the building or improvement of all roads throughout the U. S., the network would be much sparser than has been developed over the past few decades, and many existing roads would return to cow paths. A search of the literature reveals a notable absence of agreement regarding the criteria that should be used to evaluate the need for new or improved road systems. This leads to the conclusion that until research on the subject results in the determination of more objective measures, each case must be examined on its own merits, taking into account the purposes the system is designed to fill.

The vast expanse of Northwest North America and the extremely low density of its population make it impossible to develop interregional highways whose traffic densities will be sufficient to recover the costs of building the roads through normal direct taxes on highway users. On the other hand, in the absence of a suitable transportation system both the rate of growth and the absolute economic development of the Region may be materially and unnecessarily retarded. This premise is, in fact, the primary reason for the present study. The findings indicate that "tourists" offer one of the best opportunities for economic growth of the Region and the principal resource requiring development of an improved interregional transportation system for its full economic possibilities to be realized. The integrated system recommended to encourage the economic development of Northwest North America should be examined using as a basis criteria that will show whether or not economic gain is in fact obtainable by the Region through development of the system. Moreover, the analysis should determine whether or not there is reasonable probability that the capital and maintenance costs of the system can be recovered by the governments underwriting the program through increases in tax revenues within the Region.

Average tax revenues over the past several years as a percentage of Gross National Product (GNP) have been about as follows:

U. S. Government	15-1/2 per cent
State and Local Governments	6-1/2 per cent
Canadian Government	14 per cent
Provincial and Municipal Governments	6 per cent

Using these percentages as a basis, the total estimated tax revenues obtained from expenditures by outside travelers in the Region would be about as follows:

U. S. Government	$23 million
Alaska State and Local Governments	9.5 million
Canadian Government	18.5 million
Provincial and Municipal Governments	8 million
Total	$59.0 million

Subtracting the estimated 1960 tax revenues of $7 million from interregional highway travelers gives an estimated increase in annual tax revenues by 1980 of $52 million, or almost 2-1/2 times the annual costs of amortizing and maintaining the integrated system.

A check on the above estimates based on GNP can be made by using a more direct method of determining the potential tax revenues. Direct income to the U. S. Government from development of the integrated system would be obtained from expenditures of users of the system while in the State of Alaska. This income would be derived primarily from four sources: (1) personal income taxes, (2) corporate income taxes, (3) federal gasoline taxes, (4) excise and special taxes, i.e., liquor, cigarette, jewelry, fur, etc.

Assuming that the average new worker resulting from expansion of "tourism" in Alaska received wages and salaries equivalent to present average Alaska rates, federal income tax revenues attributable to the 14,800 additional primary and supporting workers required in the expansion of highway tourist travel in Alaska would amount to about $11 million annually. As a further check, national federal individual income taxes have averaged 7.8 per cent of GNP over the past several years. Using the latter basis, the personal income tax receipts based on estimated highway travelers' expenditures of $146.2 million would be almost $11.5 million. Corporate federal income taxes have averaged 4.9 per cent of GNP over the same time period. Using that as a basis, corporate income taxes would amount to $7.2 million. The fact that many of the enterprises would be small operations, however, makes it likely that actual corporate income taxes would be somewhat less, possibly in the range of $4 to $5 million. Federal gasoline taxes, based on the assumption that average travel within Alaska would amount to 2500 miles per vehicle would be about $1 million. Federal taxes on liquor, jewelry, cigarettes, et al., would amount to about another $1.5 million. Thus, a minimum of about $18 million in additional taxes would be collected from expenditures made by travelers using the integrated road system as a means of visiting Alaska. This compares reasonably well with the estimated tax return of $23 million based on GNP. If secondary and tertiary effects (repeated dollar turnover) on taxes obtained as a result of the expanded expenditures were taken into account, the returns to the Federal Government over a period of years would, of course, be substantially greater. Thus, the estimated tax revenues based on GNP are believed to be valid and are used in estimating the economic feasibility of developing the system.

Annual maintenance costs for the integrated highway systems at $2500 per mile can be broken down as follows:

Alaska Highway – Charlie Lake to Alaska border,
1169 miles at $2500/mile = $2.9 million

British Columbia - Route 5, Hazelton, to Yukon border, 518 miles at $2500/mile	=	1.3 million
Petersburg Highway - Route 5 to Alaska border, 81 miles at $2500/mile	=	0.2 million
Haines Cutoff - Alaska border to Yukon border, 40 miles at $2500/mile	=	0.1 million
Juneau Road - Route 5 to Alaska border, 71 miles at $2500/mile	=	0.18 million
Yukon Territory - Route 5, British Columbia border, to Alaska Highway, 30 miles at $2500/mile	=	$0.08 million
Haines Cutoff - British Columbia border to Alaska Highway, 60 miles at $2500/mile	=	0.15 million
Alaska - Petersburg Highway, British Columbia border, to Popof Creek, 15 miles at $2500/mile	=	0.03 million
Haines Cutoff - British Columbia border to present Highway, 22 miles at $2500/mile	=	0.06 million
Juneau Road - British Columbia border to Juneau, 50 ± miles at $2500/mile	=	0.12 million
Total		$5.1 million

On the other hand, more than 75 per cent of the proposed integrated system comprises upgrading existing roads already requiring annual maintenance (including the Stewart-Cassiar Road). Costs per mile of maintaining these existing roads may vary from costs of maintaining the proposed integrated system, being either higher or lower depending on the particular situation. This problem has been discussed by Brown & Root (Supplement I). Assuming, however, that maintenance costs would be roughly similar, new maintenance costs chargeable to the system would comprise 418 miles in British Columbia, and about 65 miles in Alaska. Costs of maintaining the Haines Cutoff as an all-year road would require substantial additional maintenance on about 60 miles in Yukon territory and 40 miles in British Columbia.

Thus, assuming that maintenance costs for existing and proposed improved roads would be similar, new maintenance costs, including the Canadian portion of the Haines Cutoff at $2500/per mile, would be as follows:

British Columbia, 458 miles at $2500/mile	=	$1.15 million
Yukon Territory, 60 miles at $2500/mile	=	0.15 million
Alaska, 65 miles at $2500/mile	=	0.16 million

Estimated annual increased gasoline tax revenues by 1980, based on 1960 tax rates, that may be derived from interregional users within the Region would be about $3.9 million, distributed as follows:

Alaska - $1.1 million (310,000,000 vehicle miles)
British Columbia - $1.5 million (250,000,000 vehicle miles)
Yukon Territory - $0.4 million (120,000,000 vehicle miles)
U. S. Government - $0.9 million (310,000,000 vehicle miles)

Each of these potential additional revenues is greater than the estimated cost of maintaining the new sectors of road within each governmental boundary. Only in the case of British Columbia is the margin between potential gasoline tax revenues and maintenance costs so close as to make it likely that the road maintenance costs in the early years of use might be greater than the revenues.

There would, of course, be substantial benefits to intraregional and intrastate or provincial users of the road system, as well as additional gasoline tax revenues. On the other hand, some portion of the revenue obtainable from interregional travelers should be apportioned to maintenance of other roads used by such travelers within the Region.

It has been shown that the potential net increases in tax revenues from expenditures of travelers using the integrated highway system by 1980 would be substantially greater than the cost of amortization and maintenance of the integrated road system at that date. It is also important to evaluate the projected timing that would be required to effect a net recovery of the costs involved in development of the system. Figure IX-1 shows this projected timing based on a 6-year road building program starting in 1962 at a steady annual rate of $40 million per year.

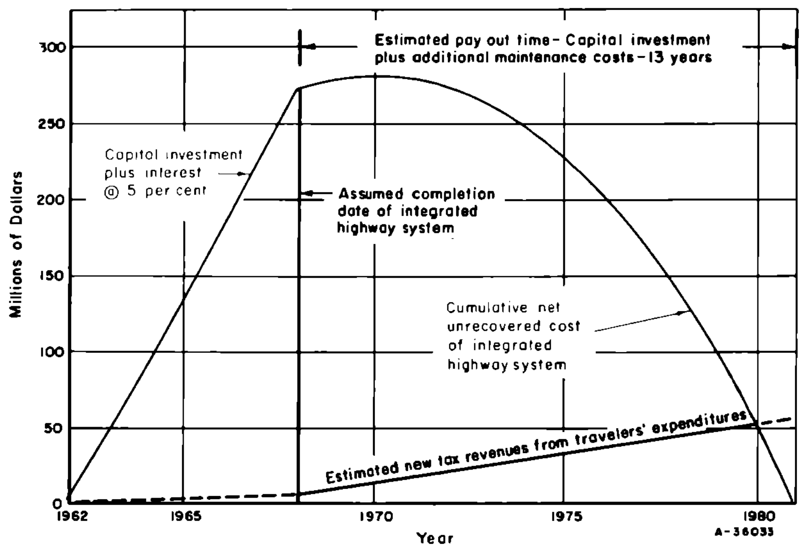

FIGURE IX-1. PROJECTED TIMING OF NET COST RECOVERY – INTEGRATED HIGHWAY SYSTEM

The estimated pay out time for the capital investment with interest rates at 5 per cent and the recovery of the additional maintenance costs amounting to $1.5 million per annum would be 13 years. This pay out time as shown assumes that expenditures of travelers prior to completion of the integrated system would increase from present levels at a rate that would double present expenditures by 1970. This is believed to be feasible as sections of the system would be completed prior to 1968 providing more ready access to the Region. Starting in 1968, however, the tax revenue from expenditures by travelers using the system would be substantially greater, reaching $52 million annually by 1980. At this estimated rate of growth in tax revenue from expenditures, the cumulative costs of the integrated system would be recovered by the end of 1981.

Obviously, Figure IX-1 is an oversimplification of the economic factors involved. The rate of increase in travel to the area will vary from year to year depending on various factors such as tourist attractions, accommodations, business conditions, and promotional activities. On the other hand, it is believed that Figure IX-1 demonstrates the economic feasibility of developing the integrated highway system. The potential growth in expenditures by travelers would provide a sound and highly desirable base for the rapid economic development of the Region, enabling its inhabitants to utilize their own expanded income for further economic developments within the Region and lessening the need for continuing "outside" assistance. Equally important, the costs of development of the system should be fully recovered well within the normal 20-year amortization period for highways from tax revenues obtained by the various Governments that would be involved in underwriting the program.

X. FINANCING THE PROGRAM

Discussion in the preceding section has shown that financing of the program would have to be by intergovernmental action. Virtually all of the program presented involves building of new roads in British Columbia and improving existing roads in British Columbia and the Yukon Territory. On the other hand, Alaska would be the principal beneficiary from expenditures by interregional travelers within the Region obtained through development of the integrated system, estimated expenditures by travelers in Alaska being essentially equal to the combined expenditures in British Columbia and Yukon Territory. Benefits to be derived by inhabitants of the Region through use of the system would also be substantial for all Regional governments.

It is believed that the development of the integrated system can be supported on the basis of economic returns to the Canadian and U. S. Governments. More importantly, regional development in British Columbia, Yukon Territory, Alaska, and to a lesser extent Alberta would be accelerated through the influx of "travelers' dollars", a substantial portion of which would remain in the area, vastly improving the generation of capital within the Region for its economic growth. Intangible but very real benefits would also accrue to visitors from other parts of Canada, and the U. S., and other countries.

Because of the international considerations involved, it would be inappropriate to suggest specific recommendations as to how government financing might be distributed among the various interested parties. This is a matter that can be decided only after proper international discussions leading to acceptance by the various governments of the premise that the proposed program would not only be self-sustaining but is deemed of sufficient importance and urgency to command the appropriation of the needed monies.

APPENDIX A

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APPENDIX B

LIST OF ORGANIZATIONS AND INDIVIDUALS INTERVIEWED*

Company and Location

Alaska Chamber of Commerce, Juneau
Alaska Concrete Conduit Co., Anchorage and Fairbanks
Alaska Concrete Products Co., Div. of Am.-Marietta, Anchorage
Alaska Dept. of Fish & Game, Juneau
Alaska Dept. of Natural Resources, Juneau
Alaska Dept. of Public Works, Juneau
Alaska Dept. of Revenue, Juneau
Alaska Executive Dept., Juneau
Alaska Housing Authority, Anchorage
Alaska Lumber & Pulp Co., Seattle and Sitka
Alaska National Bank, Fairbanks
Alaska Overland Bus Co., Fairbanks
Alaska Railroad, Anchorage
Alaska Salmon Industries, Seattle
Alaska Steamship Co., Seattle
Alberta Dept. of Highways, Edmonton
Alberta Dept. of Industry & Dev., Edmonton
Alberta & N.W. Chamber of Mines & Resources, Edmonton
Alberta Motor Transport Assoc., Edmonton
Aluminum Company of America, Pittsburgh
Aluminium, Ltd., New York
American Metal Climax, Inc., New York
American Smelting & Refining Co., New York
Anaconda Copper Co., New York
Anchorage Chamber of Commerce, Anchorage
Anchorage City Govt., Anchorage
Anchorage Daily Times, Anchorage
Anchorage Pipeline Co., Anchorage
Anchorage Port Commission, Anchorage
Anderson, Al (Consultant), Juneau
Arctic Alaska Tours, Seattle
Arctic Alaska Travel Service, Fairbanks
Bear Creek Mining Co., New York
Colonel S. H. Bingham (Ret.) (Consulting Engr.), New York
Ivan Bloch & Assoc., Portland, Ore.
Boyd, Albert (Consultant), Whitehorse
Brewis & White, Toronto
British-American Oil, Whitehorse
British Columbia Govt., Depts. of Lands & Waters, Forests, Mines, Highways, Finance, Ind. Dev. Trade & Commerce, Victoria
British Columbia Research Council, Vancouver
Bunker Hill & Sullivan, San Francisco
Calgary Power, Ltd., Calgary
California Division of Mines, San Francisco
Canada, Dept. of Defense, Ottawa
Canada, Dept. of External Affairs, Ottawa
Canada, Dept. of Fisheries, Pacific Area, Vancouver
Canada, Dept. of Mines and Tech. Surveys, Geological Survey of Canada, Ottawa
Canada, Dept. of Northern Affairs and Nat'l. Resources, Ottawa
Canada, Dept. of Transport, Ottawa
Canada Tungsten Corp., Toronto
Canadian Freightways, Ltd., Calgary
Canadian Petroleum Assoc., Calgary
The Carrington Co., Seattle
Cassiar Asbestos Co., United Keno Hill Mining Co., Toronto, Vancouver, and Whitehorse
Chicago & Northwestern Railway, Chicago
Civil Aeronautics Admin., Washington, D.C.
Colorado Oil & Gas Co., Denver
Consolidated Mining & Smelting Co., Vancouver
Conwest Exploration, Toronto and Vancouver
Cordero Mining Co., Palo Alto
Cordova Airlines, Inc., Anchorage
Dant & Russell, Inc., Portland, Ore.
Diamond Alkali Co., Cleveland, O.
E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.
Exploration Services, Inc., Fairbanks
Fairbanks Chamber of Commerce, Fairbanks
Fairbanks Daily News-Miner, Fairbanks
Falconbridge Nickel Mines, Ltd., Toronto
Felix Toner & Assoc., Juneau
First Natl. Bank of Anchorage, Anchorage
Fremont Mining Co. and W. S. Moore Co., Duluth
Georgia-Pacific of Alaska, Portland, Ore., and Juneau
Goodnews Bay Mining Co., Seattle
Great Northern Railroad, St. Paul
Haines Chamber of Commerce, Haines
Herbert, Charles (Consulting Geologist), Anchorage
Homestake Mining Co., San Francisco
Hudson Bay Exploration & Development Co., Toronto
Humble Oil Co., Houston
Imperial Oil, Ltd., Edmonton
International Nickel Co. of Canada, Toronto
International North Pacific Fisheri Commission, Vancouver
Jewell Ridge Coal Co., Tazewell, Va.
Jones, Llewellyn (Transp. consultant), Seattle
Kaiser Aluminum & Chemical Co., Oakland, Cal.
Kennco Exploration, Vancouver
Kennecott Copper Corp., New York
Ketchikan Chamber of Commerce & City Govt.
Ketchikan Cold Storage Co., Ketchikan
Ketchikan News, Ketchikan
Ketchikan Pulp Co., Ketchikan
Ketchikan Spruce Mills, Seattle
Libby, McNeil, Libby, Chicago
Marple's Business Round-up, Seattle
Martin Van Lines, Anchorage
Minshall & Smith, Vancouver
Molybdenum Corp. of America, New York
Moneta Porcupine Mines, Ltd., Toronto
Monsanto Chemical Co., St. Louis
Mt. Andrew Mining Co. (Utah Const.), Ketchikan
National Bank of Alaska, Anchorage
National Bank of Commerce, Seattle

*In addition, large numbers of companies and persons, too numerous to list, were contacted by letter or phone, or attended group meetings.

Company and Location

Newmont Mining Corp., New York
Newmont Mining Corp. of Canada, Ltd., Vancouver
Noranda Mines Ltd., Toronto
Noble, James A. (Consultant), Pasadena
Northern Alberta Railways, Edmonton
Northern Commercial Co., Seattle
O'Connor, Donald (Consultant), Washington, D.C.
The Ohio Oil Co., Littleton, Colo., and Findlay, O.
Oil & Gas Conservation Bd., Calgary
Olin-Mathieson Corp., Baltimore, Md.
Oregon Portland Cement Co., Portland, Ore.
Pacific Area Travel Assoc., San Francisco
Pacific Great Eastern Railway, Vancouver
Pacific-Northern Airlines, Inc., Seattle and Anchorage
Pacific-Northern Timber Co., Portland, Ore., and Wrangell
Pacific Northwest Co., Seattle
Pacific Northwest Trade Assoc., Seattle
Pan American Petroleum Co., Tulsa and Calgary
Parks, Charles F. (Consultant), Palo Alto
Peace River Power Dev. Co., Vancouver
Pennsalt Chemical Co., Philadelphia
Petersburg Chamber of Commerce, Petersburg, Alaska
Petersburg Cold Storage Co., Petersburg, Alaska
Phelps Dodge Corp., New York
Phillips Travel Agency, Anchorage
Prospectors Airways Co., Ltd., Toronto
Puget Sound – Alaska Van Lines, Anchorage and Seattle
Puget Sound Pulp & Timber Co., Bellingham, Wash.
Quebec Metallurgical Industries, Ltd., Ottawa
Rayonier Canada, Ltd., Vancouver
Reed & Martin, Inc., Fairbanks
Ranworth Exploration, Ltd., Toronto
Reynolds Mining Co., Richmond, Va.
Richfield Oil Co., Anchorage and Los Angeles
Rogers, George (Consultant), Juneau
Royal Engineers, Canadian Army, Whitehorse
Sampson Cordage Co., Bellingham, Wash., and Juneau
Seattle First Natl. Bank, Seattle
Shell Fish Cannery, Ketchikan
Sitka Chamber of Commerce, Sitka
Skagway City Govt. & Ch. of Commerce, Skagway
Standard Oil of Cal., San Francisco
Swalling Const. Co., Anchorage
C. T. Takahashi & Co. Inc., Seattle
Union Carbide Corp., New York
Union Carbide Ore Company, New York
Union Oil Co. of California, Anchorage and Calgary
U. S. Bureau of Mines, Douglas, Alaska, and Washington, D.C.
U. S. Bureau of Public Roads, Juneau
U. S. Bureau of Reclamation, Juneau
U. S. Consulate, Vancouver
U. S. Dept. of Agriculture, Washington, D.C.
U. S. Dept. of Commerce, Washington, D.C.
U. S. Dept. of Defense, Washington, D.C.
U. S. Dept. of Interior, Alaska Field Committee, Juneau
U. S. Dept. of Interior, Bureau of Land Management, Juneau and Washington, D. C.
U. S. Dept. of Interior, National Park Service, Juneau and Washington, D. C.
U. S. Embassy, Canada, Ottawa
U. S. Forest Service, Juneau and Washington, D.C.
U. S. Bureau of Com'l. Fisheries, Washington, D.C.
U. S. Geological Survey, Menlo Park, Washington, D. C. and Juneau
U. S. Smelting Refining & Mining Co., Fairbanks and Seattle
U. S. Steel Corp., Pittsburgh
U. S. Steel Corp., Columbia Mining Div., San Francisco
University of Alaska, College
Usibelli Coal Co., Fairbanks
Utah Construction Co., Menlo Park
Vanadium Corp. of America, New York
Ventures, Ltd., Toronto
Joseph B. Ward Associates, Seattle
Wenner-Gren British Columbia Dev. Co., New York and Vancouver
White Pass & Yukon Route, Skagway, Vancouver, and Whitehorse
Wien Alaska Airlines, Nome
Wrangell Lumber Co., Wrangell
Yukon-Alaska Refiners & Dists., Vancouver
Yukon Equipment Co., Fairbanks
Yukon Territory Governmental Authorities, Whitehorse