SOUTHCENTRAL RAILBELT AREA ALASKA
UPPER SUSITNA RIVER BASIN

INTERIM FEASIBILITY REPORT

423

HYDROELECTRIC POWER

AND RELATED PURPOSES

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12 DECEMBER 1975

SOUTHCENTRAL RAILBELT AREA, ALASKA

INTERIM FEASIBILITY REPORT

HYDROELECTRIC POWER AND RELATED PURPOSES FOR THE UPPER SUSITNA RIVER BASIN

THE STUDY AND REPORT

U.S. Army Corps of Engineers, Alaska District

PREPARED BY THE

ALASKA DISTRICT, CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

12 DECEMBER 1975

SYLLABUS

The present electrical power system of the Railbelt area of Southcentral Alaska consists primarily of natural gas thermal and turbine plants in the Anchorage area and coal-fired thermal plants in the Fairbanks area. Power demand, presently 2 billion kilowatt-hours annually, is projected to reach 5.5 billion kilowatt-hours by 1980 and 15 billion by the year 2000. This demand could be met through expanded use of natural gas, coal, and petroleum; however, recognition of the limited supply and rapid rate of depletion of these vital nonrenewable resources demands their conservation and most beneficial use.

This interim study is to determine the feasibility of providing electrical energy to the Railbelt area through the development of the renewable hydroelectric resource potential of the Upper Susitna River Basin. The study finds such development technically, economically, and environmentally feasible and justified.

The study finds that the plan best serving the public interest consists of a two-dam system utilizing the Watana and Devil Canyon damsites near miles 165 and 134, respectively, on the Susitna River. The Watana Dam, to be constructed first, would be an 810-foot-high earthfill structure with a powerplant and appurtenant access, transmission, and other facilities. The Devil Canyon Dam would be a 635-foot-high concrete thin-arch structure with a powerplant and appurtenant facilities.

The system, including limited visitor and recreation facilities, would have a project cost of $1,520,000,000, and provide 6.91 billion kilowatt-hours of energy annually. Annual costs of $104,020,000 would be exceeded by annual benefits of $137,876,000, and would give a benefit-to-cost ratio of 1.3 as compared to a conventional coal-fired generation alternative.

SOUTHCENTRAL RAILBELT AREA, ALASKA
INTERIM FEASIBILITY REPORT FOR HYDROELECTRIC POWER AND RELATED
WATER RESOURCES DEVELOPMENT FOR UPPER SUSITNA RIVER BASIN

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THE STUDY AND REPORT

PURPOSE AND AUTHORITY

Due to the continuing rapid population growth in the Southcentral Railbelt area of Alaska and because of the increasing national concern over the need to conserve the nation's nonrenewable energy resources, the Committee on Public Works of the U.S. Senate adopted a resolution on 18 January 1972 requesting a review of the feasibility of providing hydropower to the Southcentral Railbelt area. The resolution is quoted as follows:

> "That the Board of Engineers for Rivers and Harbors created under the provisions of Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the reports of the Chief of Engineers on: Cook Inlet and Tributaries, Alaska, published as House Document Number 34, Eighty-fifth Congress; Copper River and Gulf Coast, Alaska, published as House Document Number 182, Eighty-third Congress; Tanana River Basin, Alaska, published as House Document Number 137, Eighty-fourth Congress; Yukon and Kuskokwim River Basins, Alaska, published as House Document Number 218, Eighty-eighth Congress; and other pertinent reports with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to the Susitna River hydroelectric power development system, including the Devil Canyon Project and any competitive alternatives thereto, for the provision of power to the Southcentral Railbelt area of Alaska."

While the primary purpose of this report is to respond to this resolution, plan formulation will be based on existing national policy and will give full consideration to the economic, social, and environmental concerns of the public, in order that any recommended plan will insure the maximum sustained public benefit from the use of the water resources of the region.

SCOPE OF THE STUDY

The study and report are of feasibility scope and are not intended to be a detailed project design. The report is an Interim Report on the Upper Susitna River Basin in partial response to the Congressional Resolution.

The study is a systematic examination of the economic, social, and environmental conditions of the Railbelt area as they relate to electrical energy needs and hydroelectric and related water resource potential. It embodies the concepts of multi-objective planning in accordance with the directives and guidance provided by the National Environmental Policy Act of 1969 (NEPA), Section 122 of the River and Harbor and Flood Control Act of 1970, and the Principles and Standards for Planning Water and Related Land Resources, promulgated by the Water Resource Council in 1973. Findings of preliminary studies completed are summarized and an evaluation of possible electric power generation alternatives is presented along with the selection of the most feasible development plan for the Upper Susitna River Basin. Investigations and coordination relative to this study were made in sufficient detail to permit the identification of public needs, an assessment of existing and probable future conditions and resource capabilities, the establishment of specific planning objectives, and the formulation and selection of the plan which represents the best possible response to the study authority and planning objectives.

STUDY PARTICIPANTS AND COORDINATION

The Corps of Engineers had primary responsibility for conducting the study, consolidating information from other agencies, formulating the recommended plan, and preparing the report. The Alaska Power Administration had the responsibility of preparing analyses on the marketability of power in the Railbelt and on the transmission system which will be required to deliver the power to the demand centers. Other Federal, State, and local agencies providing advice and information include, but were not limited to:

Federal Power Commission, U.S. Bureau of Reclamation, Bureau of Land Management, Bureau of Outdoor Recreation, Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service, U.S. Bureau of Mines, Soil Conservation Service, Alaska Railroad, Federal-State Land Use Planning Commission for Alaska, Alaska State Clearinghouse, Alaska Department of Fish and Game, Alaska Division of Parks, Cook Inlet Regional Corporation, and Ahtna, Incorporated.

THE REPORT

The results of the studies for the Railbelt area are presented in two volumes--the main report and the appendixes. The main report presents a nontechnical summary of the results of the study for technical and nontechnical reviewers.

The first appendix is a technical report containing more detailed information on environmental and economic resources, plan formulation, and design considerations necessary for the technical reviewer to conduct an independent evaluation of the validity of the study results. Appendix 2 contains all pertinent correspondence affecting coordination among Federal, State, and local interests; and reports of other agencies.

PRIOR STUDIES AND REPORTS

Corps of Engineers Reports:

1. Cook Inlet and Tributaries, Alaska, HD 34, 85th Congress

The Chief of Engineers recommended construction of small boat basins at Seldovia; at the end of Homer Spit; and at Ninilchik; improvement of the harbor at Anchorage; and the stabilization of about 1,500 feet of riverbank by rock revetment along the Talkeetna River to protect the down of Talkeetna from flood damage.

2. Cooper River and Gulf Coast, Alaska, HD 182, 83d Congress

The Chief of Engineers recommended improved protection for small boat harbors at Seward and Valdez. The Secretary of the Interior in his report stated that no market was available for use of potential power development.

3. Tanana River Basin, Alaska, HD 137, 84th Congress

The Chief of Engineers recommended the improvement of Chena and Tanana Rivers, to provide for a diversion dam and control structure across Chena River, a diversion channel from Chena River to Tanana River, a levee, and necessary drainage facilities.

4. Yukon and Kuskokwim River Basins, Alaska, HD 218, 88th Congress

The Chief of Engineers recommended that no project be adopted at this time for improvement of the Yukon and Kuskokwim Rivers for navigation and flood control. He recommended further that the report of the District Engineer be adopted as a guide for future investigations of water resource developments in the Yukon and Kuskokwim River basins as economic conditions warrant.

5. Review of Interim Report No. 2, Cook Inlet and Tributaries, Part No. 1, Hydroelectric Power, Bradley Lake, HD 455, 87th Congress, 2d Session

The Chief of Engineers recommended the construction of a dam and reservoir at Bradley Lake, with a power-generating plant on Kachemak Bay and appurtenant power facilities.

6. Rampart Canyon Project, Volumes I and II, 1971

The Alaska District Engineer recommended that a project for hydroelectric power generation at the Rampart Canyon site on the Yukon River not be undertaken at this time because of marginal feasibility and of environmental and ecological problems.

Department of the Interior Reports:

1. U.S. Bureau of Reclamation, A Reconnaissance Report on the Potential Development of Water Resources in the Territory of Alaska, December 1948

This report described the resources of the Territory of Alaska and indicated potential for power development at 72 sites. The territory was divided into 5 regions and potential hydropower sites were studied, of which 5 were in the Susitna River basin.

2. U.S. Bureau of Reclamation, A Report on Potential Development of Water Resources in the Susitna River Basin of Alaska; August 1952

This report described the resources and potentialities of the Susitna River basin. An ultimate plan of development of hydropower resources for the basin was described, and included 12 major dams. In the ultimate plan, the total powerplant capacity would be 1.249 million kilowatts, and would provide firm annual energy of 6.18 billion kilowatt-hours. Total reservoir capacity would be 22.69 million acre-feet.

3. U. S. Bureau of Reclamation, Devil Canyon Project, Alaska, March 1961

The Commissioner of Reclamation recommended the proposed Devil Canyon Project, which consisted of two major dams and reservoirs on the upper Susitna River, a powerplant, and transmission lines and appurtenant facilities to deliver power and energy to Fairbanks and Anchorage. The largest structure would be the Devil Canyon Dam which would possess many advantages for development of hydroelectric power; however, storage capacity was not adequate. Therefore, a second dam at the Denali site was proposed, where a larger reservoir could be created with a low earthfill dam. Based on the hydrologic data available at the time of the report, the estimated energy potential of the system which consisted ultimately of four dams with first-stage development of Devil Canyon and Denali were 7.0 and 2.9 billion kilowatt-hours, respectively.

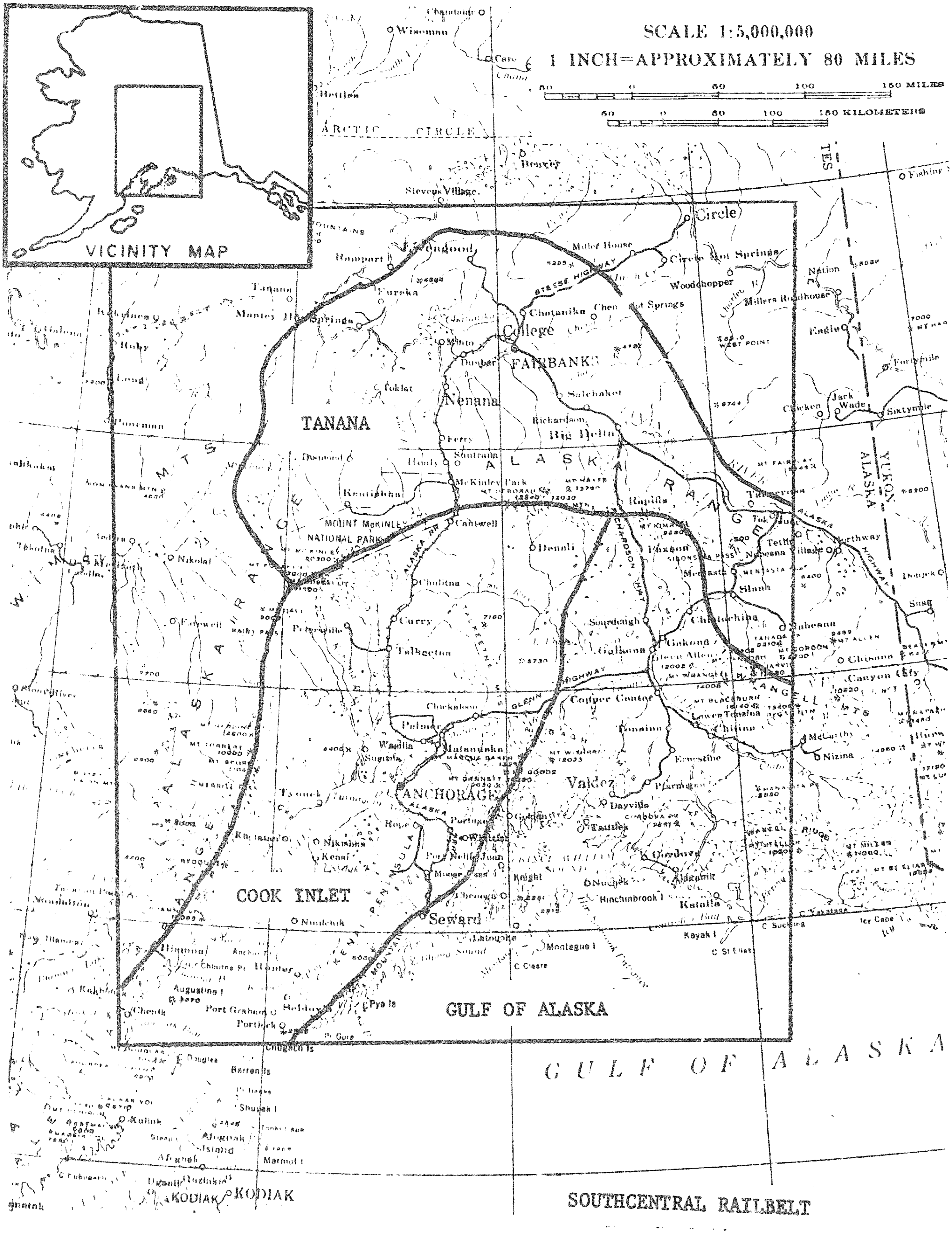
4. Alaska Power Administration, Devil Canyon Status Report, May 1974

This report was a partial update of the March 1961 report of the U. S. Bureau of Reclamation on the Devil Canyon Project. This report included updating the designs for the project features, preparation of new cost estimates, and brief analysis of power market, environmental, and economic aspects.

5. Alaska Power Administration, 1974 Alaska Power Survey, prepared for the Federal Power Commission, in five volumes

The report included information and data on resources and electric power generation, economic analysis, load projections, environmental considerations, and consumer affairs.

Other: A Reassessment Report on Upper Susitna River Hydroelectric Development for the State of Alaska, September 1974, by the Henry J. Kaiser Company. The company was considering the development of a large aluminum plant within the Railbelt area contingent upon availability of large quantities of inexpensive energy. To meet this demand, Kaiser suggested a first-stage upper Susitna River development consisting of a single high dam (termed "Devil Canyon High" and/or "Susitna I" in this report) five miles upstream from the USBR Devil Canyon damsite. Subsequent development would include power projects both up and downstream from the high dam.



SOUTHCENTRAL RAILBELT

SUBREGIONS

RESOURCES OF THE STUDY AREA

THE STUDY AREA

In keeping with the directive of Congress, the study area for this report encompasses the Southcentral Railbelt area of Alaska. This area contains Alaska's largest concentration of population and economic activity. Because of its great size and diversity, the study area is divided into three subregions for purposes of description. These are denoted as the Cook Inlet, Gulf of Alaska, and Tanana subregions. The following discussion of the study area and its economy is designed to provide information on which to base judgments as to water resource development needs and impacts of any proposed solutions. (Most of the information in this section of the report has been taken from Resources of Alaska, compiled in July 1974 by the Resource Planning Team of the Joint Federal-State Land Use Planning Commission for Alaska. It is the most comprehensive and up-to-date compendium of resource information for the study area.)

CLIMATE

Cook Inlet Subregion: At Anchorage, average annual precipitation is 14.7 inches, with half to two-thirds falling during the period July through November. The mean daily January temperature is +12.1^{o}F and the mean July temperature is +58.2^{o}F. Record low and high temperatures at Anchorage are -38^{o}F and +86^{o}F. There are about 125 frost-free days per year with the last freeze in the spring occurring about 11 May, and the first fall freeze occurring about 18 September.

Gulf of Alaska Subregion: Inland of the Chugach Mountains is an area characterized by a semi-arid climate with relatively clear skies and extreme temperatures. The mean annual temperature is generally about 29^{o}F. The southern flank of these mountains is somewhat warmer. The first freeze in the fall occurs about 14 September, and the last freeze in the spring usually occurs about 24 May, giving an annual average of about 110 frost-free days. Precipitation varies widely, as demonstrated by annual averages of 60 inches at Valdez, and 80 inches at Cordova, with 100-300 percent more precipitation in the mountains than in the lowlands. Earth tremors are common, especially along the southern portion of this subregion.

Tanana Subregion: The average annual precipitation is 11.3 inches at Fairbanks, and over one-half of the annual precipitation falls in the spring and summer months. At Fairbanks, record high and low temperatures are about 99^{o}F and -65^{o}F. The mean daily January temperature is about -16^{o}F and the mean daily July temperature is about 60^{o}F. Fairbanks averages 89 frost-free days per year.

TOPOGRAPHY AND HYDROLOGY

Cook Inlet Subregion: The subregion is characterized by rugged mountain ranges surrounding a central lowland and the ocean arm of Cook Inlet. Moderate precipitation, including the annual snowpack combined with glacial melt, generally provides a plentiful water supply. On the west side of Cook Inlet, the largest rivers are the Chakachatna and Beluga. To the north of Cook Inlet is the Susitna River, sixth largest river system in Alaska, with a total drainage area of 19,400 square miles. This system includes the major tributaries: Yentna, Chulitna, Talkeetna, and Tyonek Rivers.

To the east of the Susitna are the drainages of the Matanuska (2,170 square miles), Knik and Eagle Rivers. The rivers of the Kenai Peninsula are relatively small, the largest being the Kenai River with a 2,000-square-mile drainage area.

The low ground area within the subregion is generally free of permafrost, while permanently frozen ground may exist in the higher elevations. The Kenai Mountains and the Aleutian and Alaska Ranges contain glaciers.

The Cook Inlet subregion contains Anchorage, Alaska's largest city, as well as the communities of Kenai, Soldotna, and Homer. It also contains one of Alaska's important farming areas in the Matanuska-Susitna valleys, with Palmer being the hub city. The subregion contains the "Railbelt," extending from the deep water ports of Seward and Whittier through Anchorage to Fairbanks. A major share of the State's highway system is also here; however, large areas remain without road access.

Gulf of Alaska Subregion: This subregion includes parts of the Alaska Range, the Wrangell and Chugach-Kenai Mountains, and the Copper River Lowland. Massive mountains, rising in altitude to more than 16,000 feet in the Wrangells support the largest ice fields and glaciers in North America.

Principal watershed of the subregion is the Copper River system with a 24,400-square-mile drainage area. It drains the south slopes of the Alaska Range, south and west slopes of the Wrangell Mountains, most of the Chugach Mountains, the Copper River Basin, and a small section of the Talkeetna Mountains. The land surface is largely rough and mountainous, with a narrow coastal plain along the Gulf and broad lake basin in the Gulkana area between the mountain systems.

The coastal portion of the subregion is generally free of permafrost, while the interior portion is underlain by discontinuous permafrost. Glaciers cover most of the higher peaks in the Wrangell Mountains and nearly all of the crest of the Kenai-Chugach Mountains, which separate the coastal area from the interior.

Most of the larger communities in this subregion are accessible by road. A notable exception is Cordova. Whittier is linked to Portage by rail and to Valdez by ferry.

Tanana Subregion: A broad level to rolling plain occupies the central and southwestern part of the subregion, flanked by mountains to the north and south. The entire subregion is drained by the Tanana River and its tributaries.

The Tanana subregion lies within the discontinuous permafrost zone of the State. Glaciers occur along most of the southern boundary of the area.

The Tanana subregion has one of the most developed surface transportation systems in Alaska. The Alaska Highway bisects the area; the Tok cutoff and Richardson Highway both provide all-weather routes to Anchorage, as does the Parks Highway.

WILDLIFE--FISHERIES

Alaska is endowed with geographic characteristics that make possible a highly productive fishing region. Alaska's coast covers a broad geographical range in latitude and longitude, and includes every type of coastal system found in the Lower 48 States, with the exception of the tropical area. Coastal Alaska, with an extensive intertidal and littoral shore area, provides the environment necessary to sustain its fisheries production. Alaska produces 10 to 12 percent of the total value of U.S. fisheries products (422 million pounds worth $92 million in 1972).

Following is a description of the fishery resources of the study area by subregion.

Cook Inlet Subregion: Pink salmon are the most abundant anadromous fish in the area, with the greatest numbers arriving to spawn in even-numbered years. Red salmon are next in abundance and are found primarily in the Kenai and Tustumena Lake drainages. Chum and silver salmon are found in most of the coastal streams, and king salmon are present in streams north of Anchor River on the east and Beluga River on the west.

Dolly Varden are found throughout the area; some remain in fresh water; others are anadromous. Rainbow trout inhabit some lakes and streams on the Kenai Peninsula and most of the Susitna River drainage.

Grayling are indigenous to the Susitna River drainage and other westside streams flowing into Cook Inlet, and they have been successfully introduced into freshwater lakes. Whitefish and lake trout are also found in the area.

Sport fisheries are intensively used in many waters of the subregion. This area contains over half the people of the State, as well as most of the roads. Sport anglers use cars, airplanes, boats, and snowmachines to reach most parts of the area. Sport fish available are rainbow trout, Arctic grayling, Dolly Varden, Arctic char, lake trout, burbot, whitefish, black rockfish, and five species of salmon. Clam diggers pursue razor clams, butter clams, and other varieties of clams on the beaches of the Kenai Peninsula and west shores of Cook Inlet.

Freshwater sport fishing is available throughout the area. Saltwater fishing in Cook Inlet is confined mostly to Kachemak Bay and at the mouth of Deep Creek, south of Kenai. The numbers of fish and shellfish harvested by sport fishermen are unknown. Many lakes throughout the area are stocked with salmon, trout, or grayling.

Gulf of Alaska Subregion: Since much of this subregion is mountainous, the fisheries habitat is characterized by many short, steep coastal streams and the rather large drainage of the Copper River. The entire mountainous area is heavily glaciated, and many of the streams carry a high load of glacial sediment. There is a paucity of lakes, for such a large area.

Pink and chum salmon utilize the short coastal streams. Silver salmon spawn and their fry develop in somewhat larger streams where the young can survive for at least one year. Red salmon are found primarily in drainages that contain a lake or lakes, such as the many lakes of the Copper River drainage. King salmon spawn in the upper reaches of the Copper River drainage. Dolly Varden are present throughout the coastal stream systems. Arctic grayling are confined to the clearwater systems in the upper portion of the Copper River drainage and have been successfully introduced in the Cordova area. Rainbow trout are present, as well as lake trout, whitefish, and burbot.

Important marine fish and shellfish are herring, halibut, red snapper, black cod, king crab, tanner and Dungeness crab, shrimp, scallops, and razor clams.

The most sought-after sport fish are the five species of Pacific salmon, Dolly Varden, rainbow trout, Arctic grayling, lake trout, and burbot.

Tanana Subregion: Chum salmon spawn in a number of tributaries of the Tanana River. Silver salmon spawn and rear in the Chatanika and Salcha Rivers, and Clearwater Creek. King salmon spawn and rear in the same streams as the silver salmon, plus the Goodpaster, Delta, and Chena Rivers. Grayling, whitefish, and northern pike are present throughout the area. Lake trout, sheefish, and cisco are scattered in the various drainages.

Sport fishing is assisted by the extensive road system. The Tanana drainage receives the greatest angling pressure in the interior and arctic areas. Grayling receives more pressure than any other species. Other species sought are lake trout, sheefish, and whitefish.

WILDLIFE--BIRDS

Cook Inlet Subregion: Primary waterfowl habitat lies in the Matanuska-Susitna River glacial outwash plain and the Kenai lowland. Trumpeter swans are the most important breeding waterfowl; geese do not nest in appreciable numbers, and ducks are in lower numbers than in interior habitats. During migration, however, some areas become highly impacted with ducks and geese. As many as 70,000 have been estimated to be in the Susitna River valley at one time.

Coastal areas support moderate populations of bald eagles and peregrine falcons. Rainy, Broad, and Windy Passes are migration routes for peregrines which move th[illegible]gh the Susitna River valley.

Golden eagles and gyrfalcons occupy the more upland areas. Great horned owls, great grey owls, and rough-legged hawks are some of the characteristic raptors of the spruce-birch forest of the more northern areas. Other raptors known to breed in this subregion include goshawks, sharp-shinned hawks, red-tailed hawks, Harlan's hawks, marsh hawks, ospreys, pigeon hawks, and short-eared owls.

Colonial nesting seabirds are not abundant; however, several colonies have been identified and others probably exist.

The marshes and lake shores support a host of shore and wading birds and the entire subregion is host at one time or another to most of the passerine species that occur in Alaska.

Resident game birds of forest and other habitats are the spruce grouse and the willow, rock and white-tailed ptarmigan.

Gulf of Alaska Subregion: Prince William Sound is an important migration route for many species of waterfowl.

The Copper River delta and the Bering Glacier outwash plain contain about 15-18 townships of exceptional value to waterfowl. This region is the principal nesting area for the world's population of dusky Canada geese, and may produce more ducks per square mile than any other known area in Alaska except the Yukon Flats. Trumpeter swans reach their greatest densities here. In spite of its unique nesting populations the delta is probably most important as a staging and feeding area for migratory fowl bound to and from the arctic and subarctic nesting areas to the north.

At the confluence of the Bremner and Copper Rivers, 40 miles from the mouth of the latter, are several townships of trumpeter swan habitat second only to the Copper River delta in importance.

The entire coastal area is habitat for seabirds of various species. At least 48 major seabird colonies have been identified in this subregion, and undoubtedly many more exist.

The nearly 200 square miles of tidal flats in Orca Inlet and the Copper River delta probably support one of the greatest remaining concentrations of birdlife in existence.

Resident game birds of forest, treeless, and other habitats are spruce, ruffled, and sharp-tailed grouse; willow, rock, and white-tailed ptarmigan.

Tanana Subregion: This subregion includes waterfowl habitat along the Tanana River and on tributary streams. Although it is primarily a production area, large numbers of ducks and geese utilize portions of the subregion as resting and foraging areas during migration. Primary species are trumpeter swans, white-fronted and lesser Canada geese, widgeons, scaups, pintails, green-winged teals, mallards, and canvasbacks. Nearly all major rivers of the interior regions have small intermittent areas of flood plains that are utilized extensively by nesting waterfowl.

Peregrine falcons, ospreys, and bald eagles are known to nest in the Tanana valley. Other raptors present throughout the area include: goshawks and sharp-shinned hawks; great-horned, great grey and boreal owls, generally in forested areas; and red-tailed, Harlan's, Swainson's, rough-legged, marsh, pigeon, and sparrow hawks and gyrfalcons (the latter usually above 2,500 feet elevation). Snowy and short-eared owls range over the open country.

The only seabirds likely to be found in this region are herring, mew, and Bonaparte's gulls, Arctic terns, and long-tailed jaegers.

Resident game birds of forest and other habitats are spruce, ruffed, and sharp-tailed grouse, and willow, rock, and white-tailed ptarmigan.

WILDLIFE--MAMMALS

Cook Inlet Subregion: Some of Alaska's densest black bear populations live on the Kenai Peninsula, in the Susitna valley, and in the mountains between Turnagain and Knik Arms. Density is lower in the interior regions.

The brown-grizzly bear is common throughout the subregion with lowest numbers in the Anchorage area and western Kenai Peninsula.

Wolves are most common in the interior and Susitna drainage portions of the subregion.

Wolverines are common throughout, except in areas of high population. They are most abundant in the interior portions of the subregion.

Several herds of barren ground caribou use portions of the subregion: the Nelchina herd in the northeast section, the McKinley herd in the northcentral section, and the Kenai herd on the Kenai Peninsula.

Dall sheep are present throughout the Alaska Range, Talkeetna, Chugach, and Kenai Mountains. Populations fluctuate in response to weather, range condition, and susceptibility to predation.

Moose are abundant throughout the subregion except in the high mountains. The Susitna Valley supports an excellent population, but the premier area is the Kenai National Moose Range, which boasts the highest population per unit of area in the world.

Mountain goats are found in low numbers in the Talkeetna Mountains and in moderate numbers on the Kenai Peninsula Range within the subregion.

Marine mammals that inhabit the waters of lower Cook Inlet are harbor seal, sea lion, sea otter, and various whales.

Other smaller mammals present include lynx, red fox, land otter, mink, marten, short-tailed weasel, beaver, muskrat, and snowshoe hare.

<u>Gulf of Alaska Subregion</u>: Black bears live throughout the subregion. Population varies from relatively high levels along the coastal areas to moderate levels in the interior areas.

Brown-grizzly bears are found throughout the subregion; the bears are less common on the west side of Prince William Sound than on the east. They are more numerous in the interior than along the coast.

Wolves are relatively abundant in the interior portions of the subregion, but quite scarce along the Prince William Sound coast. The interior population numbers about 300.

Wolverines are abundant in the interior, but not as common along the coast.

Sitka black-tailed deer are primarily confined to islands of Prince William Sound, but some occur on the mainland in the Cordova area.

Barren ground caribou inhabit the interior portion of the subregion, which contains a sizable amount of the Nelchina caribou herd's winter range.

Two distinct bison herds, the Chitina and Copper River, exist in the subregion.

Some of the most important Dall sheep range in the State is contained in this subregion.

Moose occur in greatest concentrations in the interior portions of the subregion, but have suffered a severe decline in recent years.

Mountain goats are abundant in the mountains of Prince William Sound, but present only in low numbers in the Wrangell Mountains and interior portions of the Chugach Mountains.

After being nearly wiped out in the 19th century, sea otters have made an amazing recovery. There are now about 6,000 in the Gulf of Alaska. Harbor seal, Steller sea lion, and various whales are in the Gulf.

Other smaller mammals present include lynx, red fox, land otter, mink, marten, short-tailed weasel, beaver, muskrat, and snowshoe hare.

Tanana Subregion: Black bears live throughout the area. Grizzly bears are usually found in alpine-subalpine areas and sporadically in lowlands.

Wolves range throughout the area, even near Fairbanks. Population densities are generally high.

Wolverines occur throughout the area.

Barren ground caribou of the Delta, Forty-Mile, McKinley, Mentasta, and Chisana herds use portions of this subregion.

Sizable Dall sheep populations are supported by habitat in the Alaska Range, Mentasta-Nutzotin Mountains, and Tanana Hills-White Mountains.

Moose are widely scattered and relatively abundant throughout the subregion.

Other smaller mammals present include lynx, red fox, land otter, mink, marten, short-tailed weasel, beaver, muskrat, and snowshoe hare.

AGRICULTURE AND RANGE

Cook Inlet Subregion: There are approximately 2.6 million acres suitable for production of cultivated crops in the Cook Inlet-Susitna lowlands up to elevations of 1,500 feet. Roughly 30 percent is located on the west side of the Kenai Peninsula; the balance is located in the valleys of the Matanuska and Susitna Rivers and their tributaries, with a small part near the lower Beluga River. More than 70 percent of the State's current agricultural production is derived from these areas of the subregion.

In general, only the northern portions of the lowlands receive enough moisture for continued intensive use. Most of the area will require irrigation for best results. The growing season averages up to 110 days at lower elevations, adequate for all cool-weather crops except in the northern parts where it drops to 87. The index of Growing Degree Days (the cumulative total number of degrees of mean daily temperature over 40°F for the year) varies from 1,355 in the south, to 1,940 in the mid-region and 1,785 in the northern portions. This index decreases by about 300 for each thousand-foot increase in elevation. These factors impose limitations as to which crops may be produced successfully at different locations. At present, less than 1 percent of the land is in production, and gross income is less than $4 million.

The subregion's grazing season averages about five months. Limited grasslands occur on the lower Kenai Peninsula, stream deltas, higher slopes, and on burned-over forest lands. Woodland pastures are generally of marginal value. The short grazing season is a distinct disadvantage which may or may not be overcome by proximity of croplands.

Gulf of Alaska Subregion: Potential agricultural and range resources of the subregion are mainly along the Copper and Chitina River valleys. Narrow coastal strips and stream deltas along the coast might be grazed during the summers, with removal of the animals imperative for the balance of the year.

Climate of the interior is continental in nature with warm summers and cold winters. Elevation is generally 1,000 feet or more. The area lies in the "rain shadow" of high coastal mountains, and summer precipitation is typically below 10 inches. The proximity of very high mountains and downward flows of cold air combines to render the area susceptible to summer frosts and limits reliable agricultural production to gardens and forage crops.

In its natural forested state, the lower land area has relatively little range forage value.

Some 70 farms are located in the subregion, mostly active in the Kenny Lake area. None are operated on a full-time basis. With the long winter feeding period, it is unlikely that any extensive livestock industry will develop in the near future.

Tanana Subregion: Some 3.6 million acres are suitable for production of cultivated crops. The crop lands include approximately 810,000 acres which are lowlands of the Tanana and tributary rivers, another 840,000 acres located on the northern foothills of the Alaska Range and Kuskokwim Mountains, generally south and west of Nenana.

The Tanana and upper Yukon subregions share the greatest temperature extremes in the State. Higher elevations and lowlands with poor air drainage are subject to danger of summer frost. Aside from these local drawbacks, the subregion has the best record in the State for maturing hardy grains, normally the highest criterion for assessing northern agricultural potentials.

Fairbanks, approximately in the middle of the agricultural area, averages 1,996 growing degree days, 57 days with temperatures 70°F or over, 89 frost-free days, and 8.06 inches of summer precipitation. This is both warmer and drier than either Tanana or Delta Junction, but the entire area is suitable for cool weather forages, vegetables, and hardy small grains. For sustained commercial production, fertilizers are necessary and irrigation is highly desirable.

There are no extensive grass range lands for a livestock economy. However, with improved range near crop lands, shelter, and hardy animals, the subregion could have a carrying capacity of approximately 650,000 animal units.

FORESTRY

Cook Inlet Subregion: Four forest ecosystems are represented in the subregion. The coastal Sitka spruce-western hemlock ecosystem is located on the Kenai Peninsula and the lands west of Cook Inlet. It covers 1,641,000 acres. The bottomland spruce-poplar forests cover 675,000 acres and are located primarily in the Susitna and Matanuska Valleys where spruce and cottonwood are of important commercial value. The upland spruce-hardwood forest covers a large area of 3,570,000 acres, and has commercial forest stands on about one-fourth of the acreage, primarily in the Susitna Valley. The lowland spruce-hardwood forest ecosystem has a land area of 2,867,000 acres, and can be considered noncommercial. "Commercial" refers strictly to an annual volume growth rate, not to whether the timber is accessible, or has an economic commercial value or a market.

Of the 6,362,000 acres of inventoried forest land, commercial and subcommercial forests occupy 4,004,000 acres and noncommercial forests 2,348,000 acres. The commercial forest land contains 7.0 billion board feet (International 1/4 inch rule) of sawtimber, of which 2.7 billion board feet are hardwood--primarily cottonwood, and 4.3 billion board feet are white and Sitka spruce. An additional 66.1 million board feet of dead but salvable timber could be added to the above.

The average volume is approximately 1,752 board feet/acre but can range from 100 board feet/acre to about 25,000 board feet per acre. A general rule of thumb is 15 percent deduction for defect and cull. Stand stocking is generally not as high as it could be if the stands were fully regulated and managed. Regeneration appears to be adequate. In general, the trees reach maturity for harvesting in 80 to 100 years, depending on site and product to be manufactured. The total net growth volume is about 1.8 billion board feet.

The growth volume for the entire subregion is sufficient to supply several pulp mills, particle board mills, or large sawmills if the forested lands were properly developed and managed for timber production. Presently, only a few small mills cut timber for various local use products. Some cants are produced for export to Japan for further processing. Some cottonwood logs have been exported to determine their suitability for paneling. Local markets exist and are expanding, and local and foreign demand for timber is increasing.

Gulf of Alaska Subregion: The interior forest of three different forest systems covers a total of 4,998,000 acres. The bottom land spruce-poplar forest ecosystem, 303,000 acres, is located primarily in the Copper and Chitina River valleys and can be considered essentially commercial forest land. The upland spruce-hardwood forest covers 2,211,000 acres and has local stands of commercial spruce and hardwoods.

Most of the forest stands in this ecosystem are noncommercial because of their slow growth due to poor site conditions. The lowland spruce-hardwood ecosystem covers 2,484,000 acres and is noncommercial throughout.

The best timber production land is in Native village withdrawals and Native regional deficiency areas. The major acreage of forested land lies in Federal control.

Two forest inventories were conducted in the subregion; an extensive inventory covering the entire basin, and a relatively intensive inventory covering the better bottom land forests. The following data are taken from the basin-wide inventory which lists 4,431,000 acres of total forest land for the Copper River basin of which 1,178,000 acres are commercial and subcommercial timber and 3,253,000 acres are noncommercial. Of the 2,064,000 acres of coastal forest, about 901,000 acres are considered commercial and subcommercial.

Total standing volume in the interior forests is 1.5 billion board feet (International 1/4 inch rule) consisting of 1.4 billion board feet of spruce and 52.5 million board feet of hardwoods, half of which is birch. Average volume per acre is 1,240 board feet and total annual volume growth is 28.5 million board feet. This volume can be considered the potential sustained yield for the entire Copper River basin.

The total volume of the coastal forests is about 19.8 billion board feet (International 1/4 inch rule), 67 percent of which is Sitka spruce and 28 percent is western hemlock. The potential annual harvest on the Chugach National Forest lands is 103 million board feet (International 1/4 inch rule) plus an additional 20 million board feet from other lands.

Regeneration in both coastal and interior forest systems appears to be adequate but could be improved with higher stocking density. Rotation ages for the interior forests are about 100 to 120 years and 70 to 210 years in the coastal type.

Several sawmills operate in the subregion, some sporadically and others, like the mills at Seward and Whittier, on a full-time basis. The mills produce a variety of products for local markets and cants for export to Japan.

Tanana Subregion: The three Interior forest ecosystems occupy a considerable area in this subregion. The bottom land spruce-poplar ecosystem (1.2 million acres) is found in the flood plains and on river terraces along all the major streams--primarily the Tanana River. This system can be considered commercial throughout its range.

The upland spruce-hardwood ecosystem has the greatest area, 7.3 million acres. It is partly commercial depending on the site. Much of the forest is noncommercial because the trees are very slow growing and occupy sites with thin soils, steep and dry hillsides, and northerly slopes.

The lowland spruce-hardwood ecosystem is found on poorly drained soils, usually in muskeg areas, and covers 5,184,000 acres. It should be considered noncommercial throughout its range due to small size of black spruce and hardwoods and extremely slow growth rates. The term commercial refers to trees or forest stands adding volume growth in excess of 20 cubic feet per acre each year, and does not consider accessibility.

The total volume of commercial and subcommercial standing timber is about 6.2 billion board feet. About 5.2 billion board feet of this are spruce and about 1.0 billion board feet are hardwoods (primarily birch). The overall average gross volume is 1,265 board feet/acre and the total annual volume growth is about 26.5 million board feet.

This growth can be used as an indicator of the potential annual harvest for the entire subregion. Regeneration appears adequate, but most timber stands are naturally understocked and could produce more volume if intensively managed. Although rotation rates have not been precisely determined, they are estimated at 90 to 120 years depending on the site.

Several mills are currently operating in the subregion, some sporadically and some full-time. Most of the mills are small size and saw products for local use.

MINERALS AND ENERGY

Cook Inlet Subregion: Mineral resources are abundant, and in the future will become more important to the Alaskan economy. Oil and gas produced from fields in the Cook Inlet basin have far exceeded other minerals in value.

The oil and gas-bearing sedimentary rocks of the Cook Inlet basin may be as much as 25,000 feet thick. Reserves of 2.6 billion barrels of oil and five trillion cubic feet of gas are estimated to exist in the Upper Cook Inlet. Total projected resources from the Cook Inlet Basin may be as much as 7.9 billion barrels of oil and 14.6 trillion cubic feet of gas. The resource estimates include both onshore and offshore areas.

Coal resources are large and exceed more than 2-1/2 billion short tons. Coal is present in the Broad Pass, Susitna, Matanuska, and Kenai Tertiary coal fields. Broad Pass coal ranges from subbituminous on Costello Creek to lignite at Broad Pass. Reserve estimates for the Broad Pass field are 64 million tons of indicated coal. The Susitna coal deposits are in the basins of Beluga and Chulitna Rivers and are as much as 2.4 billion short tons less than 1,000 feet deep. The Matanuska coal is in the Chickaloon formation ranging in beds up to 23 feet in thickness. It is high volatile bituminous in rank, and some have coking properties. The Anthracite Ridge contains semianthracite coal beds. The total resource estimates are 137 million short tons less than 2,000 feet deep. The Kenai field has at least 30 coal beds from three to seven feet in thickness and ranging from subbituminous to lignite in rank. Estimated resources are about 318 million short tons less than 1,000 feet deep.

Geothermal potential is high in the south part of the Alaska Range, where a volcanic belt is locally surmounted by volcanoes and lava fields; some of the volcanoes are still active and indicate deep heat reservoirs.

Clay deposits which can be used for brick manufacturing occur at Point Woronzof in the Anchorage area, at Sheep Mountain in the upper Matanuska Valley, and near Homer on the Kenai Peninsula.

Gypsum deposits occur on Sheep Mountain, about 50 miles northeast of Palmer. Reserves are calculated at 310,800 tons of indicated and 348,000 tons of inferred gypsum rock averaging 25 to 30 percent gypsum.

Limestone deposits of nearly pure calcium carbonate occur in the drainage of the Kings River and in Foggy Pass near Cantwell.

The Cook Inlet Subregion is traversed by numerous metal provinces. The subregion contains deposits of gold, silver, antimony, iron, chromite, molybdenum, copper, lead, and zinc. Like most of Alaska, past metallic production has been primarily gold, about one million ounces. In addition, nearly 300,000 tons of chromite ore and small amounts of copper ore have been produced.

Gulf of Alaska Subregion: High oil and gas potential exists in the coastal section within the Gulf of Alaska province. The many oil and gas seeps and petroliferous beds in sedimentary rocks, which exceed 25,000 feet in thickness, have attracted intensive exploration by industry. Interest has now shifted to the outer continental shelf where the presence of many folds, the possibility of reservoir rocks, and lack of intense deformation indicate high possibilities of petroleum deposits. The Copper River lowlands have low to moderate oil potential.

Coal-bearing rocks have been mapped over 50 square miles near Bering and Kushtaka Lakes in the Bering River coal field. Similar rocks appear in the Robinson Mountains east of Bering Glacier. The coal ranges upward from low volatile bituminous in the southwestern part. The beds are a few feet to 60 feet thick. The coal in part of the field has coking properties.

Geothermal energy potential is high. The Wrangell Mountains are the site of recent volcanic activity and provide a favorable environment for heat reservoirs.

Some potential for cement may exist in the limestone beds exposed near McCarthy. The beds are several hundred feet thick and quite extensive.

Sand and gravel deposits of economic significance occur in the Copper River lowlands, the Chitina Valley, and adjacent tributaries.

Metallic minerals occur in several districts. Lodes in many parts of the Copper River region contain copper, gold, silver, molybdenum, antimony, nickel, iron, lead, and zinc, but only gold, copper, and by-product silver were mined commercially. The Kennicott mines near McCarthy, and mines in the southwestern and northeastern parts of Prince William Sound, accounted for most of the 690,000 short tons of copper produced in Alaska. Two or three million dollars worth of gold and silver were produced from lodes and as by-products of copper mining in the Prince William Sound district. Gold placer deposits produced 35,000 ounces of gold and a few ounces of platinum from the Chistochina, Slana, and Nizina districts.

Gold and copper lodes are in the Seward district and eastern part of the Kenai Peninsula. Copper, gold, silver, and molybdenum lodes are between the Chitina River and the crest of the Wrangell Mountains. Other mineralized sites occur throughout the subregion.

Tanana Subregion: Low potential for oil and gas exist in the basins within the subregion. There may be potential for gas in connection with coal beds in the Tanana Basin. The remainder of the subregion is underlain by rocks that are nonporous or too structurally complex for petroleum accumulation.

Large coal deposits exist in the young basins which flank the northern front of the Alaska Range. The coal deposits in the Nenana coal field have been mined since about 1918 and are presently producing about 700,000 tons per year. The coal is lignite to subbituminous, occurs in beds 2-1/2 feet to over 50 feet in thickness, has low sulfur content, and is used for power generation and domestic use in Fairbanks. Coal resources for all fields in this belt are estimated at nearly 7 billion tons located less than 3,000 feet deep.

Geothermal potential is present in the subregion.

Sand and gravel potential is high. Outwash deposits fronting the Alaska Range are economically significant. The Nenana gravel near Healy could be utilized. Other localities with potential for sand and gravel occur in the flood plains of the Tanana River and its major tributaries.

Limestone containing a high content of calcium suitable for cement occurs in outcrops at Windy Creek and Foggy Pass near Cantwell and the railroad. Other deposits of limestone are in the Minto Flats-Dugan Hills area west of Fairbanks.

Metallic minerals are present in a number of districts. The mineral potential of the Hot Springs district is moderate and contains silver, lead, minor amounts of gold, iron, copper, and other copper associated minerals. Chromite is found south of Boulder Creek. Nickel minerals are found in the vicinity of Hot Springs Dome.

Tolovana district lodes contain gold, silver, antimony, mercury, chromium, nickel, and iron.

Fairbanks district lodes have produced important amounts of gold and small quantities of silver, lead, tungsten, and antimony ore.

Delta River district lodes contain gold and silver, molybdenum, antimony, copper, lead, zinc, nickel, and chromium minerals.

The Chisana district is well known for its lode deposits of gold, copper, silver, lead, zinc, molybdenum, iron, and antimony. Lode production from the Nabesna mine was substantial and consisted of gold and subordinate copper and silver.

HUMAN RESOURCES

Population: Since 1930, Alaska's rate of population growth has exceeded that of the contiguous United States, and even that of the western states. This population growth has been characterized by a relatively high rate of natural increase which accounted for 60 percent of the 1950 to 1960 growth, and 81 percent of the growth between 1960 and 1970. Increases in military population were significant in Alaska's growth up to 1960, after which it has remained fairly stable at about 33,000 persons, accounting for about 9 percent of total population.

Earliest records indicate that Alaska's population, around 1740 to 1780, consisted of an estimated 74,500 native people. Of this total, 40,000 were Eskimos, 16,000 were Aleuts, 6,900 were Athabascan Indians, and 11,800 were Tlingit, Haida and Tsimpshean Indians. The native population declined from that time to the early 20th century, apparently because of social disruption and disease. About 1920, improved economic and health conditions reversed the decline in the native population which is now growing rapidly but has yet to reach the level of the late 1700's.

The following table shows the proportion of native residents in the various census divisions of the study area.

Percent of Native Population in the Study Area
By Census Division, 1970

Census Division	Population	% Native
Anchorage	124,542	3
Cordova-McCarthy	1,857	15
Fairbanks	45,864	4
Kenai-Cook Inlet	14,250	7
Matanuska-Susitna	6,509	4
Seward	2,336	11
Southeast Fairbanks	4,179	12
Valdez-Chitina-Whittier	3,098	23
Yukon-Koyukuk	4,752	46

Source: Adapted from information in the 1970 Census and from the University of Alaska, Institute of Social, Economic and Governmental Research, March 1972, Vol. IX, No. 1.

Published in: Alaska Statistical Review, Department of Economic Development, Dec. 1972.

A high rate of natural increase plus migration boosted the population from 128,000 in 1950 to 227,000 in 1960. By 1970, the population had advanced to 302,000 and it is now estimated to be 386,000. The following table shows Railbelt area population in relation to State totals:

Study Area Population As Percent of Total 1/

Year	Total Alaska	Study Area	Percent of Total
1880	33,426	6,920	21
1890	32,052	8,445	26
1900	63,592	15,600	25
1910	64,356	25,964	40
1920	55,036	19,137	35
1940	72,524	25,226	35
1950	128,643	73,101	57
1960	226,167	157,979	70
1970	302,173	220,271	73
1973	330,365	245,291	74

Source Note: Population statistics for 1960 and prior years are from G.W. Rogers and R.A. Cooley, Alaska's Population and Economy, all population statistics for 1970 are from the U.S. Census, and population estimates for 1973 are from the Alaska Department of Labor.

Published in: Alaska Statistical Review, Department of Economic Development, Dec. 1972.

1/ The boundaries of the study area do not coincide with census districts and, therefore, population figures for the study area are approximate.

The Southcentral Railbelt area of Alaska contains the State's two largest population centers, Anchorage and Fairbanks, and almost three-fourths of the State's population. The Anchorage area alone has over half the residents in the State.

Employment: Alaska's civilian workforce amounted to 148,900 persons in 1974. The largest sector was government with 30 percent of the number employed. The next most important sector was trade followed by the service sector. The following table provides a tabulation of Alaskan employment.

LABOR FORCE SUMMARY - 1974

	Annual Average
TOTAL	148,900
Total Unemployment	14,900
Percent of Labor Force	10.0
Total Employment	134,000
TOTAL Non-Agricultural	128,200
Mining	3,000
Metal Mining	200
Oil and Gas	2,600
Other Mining	200
Contract Construction	14,100
Manufacturing	9,600
Food Processing	4,300
Logging-Lumber and Pulp	3,600
Other Manufacturing	1,700
Transp.-Comm. & Pub. Utilities	12,400
Trucking & Warehousing	2,200
Water Transportation	1,000
Air Transportation	4,000
Other Transportation	1,300
Comm. and Public Utilities	3,900
Trade	21,100
Wholesale	4,000
Retail	17,100
Gen. Mdse. and Apparel	4,100
Food Stores	2,000
Eating and Drinking Places	5,000
Other Retail	6,000

LABOR FORCE SUMMARY - 1974 (continued)

Finance-Ins. and Real Estate	4,900
Services	18,300
Hotel, Motels, and Lodges	2,500
Personal Services	800
Business Services	3,000
Medical Services	3,800
Other Services	8,200
Government	43,800
Federal	18,000
State	14,200
Local	11,600
Misc. and Unclassified	1,000

Source: Alaska Department of Labor

Location quotients compare the share of total personal income from an industry in Alaska to the share of total personal income arising from the same industry for the United States. A quotient greater than one indicates that Alaska is more dependent on that industry than the U. S. as a whole. The following table provides location quotients for the various employment sectors.

Location Quotients For Alaska
Vis-A-Vis United States (1960, 1971)

	1960	1971
Mining	1.6	3.7
Contract Construction	2.2	1.8
Manufacturing	.2	.2
Transportation, Communications, and Public Utilities	1.3	1.5
Trade	.7	.8
Finance, Insurance, and Real Estate	.5	.6
Service	.7	.8
Government (Excludes Military)	2.8	2.3

Source: Derived from data in Survey of Current Business and Statistical Abstract of United States, both compiled by the U.S. Department of Commerce.

Published in: Alaska Statistical Review, Department of Economic Development, 1972 Edition.

Alaska has experienced unemployment rates consistently higher than the national average. In 1974, Anchorage and Fairbanks experienced an average unemployment rate of 8.6 percent, somewhat lower than the statewide 10 percent rate of unemployment.

Income: The following table shows the per capita personal income for Alaska, far west region, and U.S. average for 1970 through 1973. This table reduces Alaskan income by a 25-percent cost of living adjustment to show an estimated real per capita income relative to other parts of the United States.

Per Capita Personal Income for Alaska, Far West Regions, and U.S. Average

Year	Alaska	Alaska -25% COL	Percent of U.S. Average	Far West Region	U.S. Average
1970	$4,603	$3,452	87.6	$4,346	$3,943
1971	4,907	3,680	88.4	4,535	4,164
1972	5,141	3,856	85.8	4,866	4,492
1973	5,613	4,210	85.6	5,322	4,918

Source: Survey of Current Business

Published in: Alaska Statistical Review, Department of Economic Development, Supplement to December 1972 Edition.

Education: Enrollment in primary and secondary schools grew at a slightly faster rate than Alaska's total population over the period since statehood. As of 1970, a significantly higher share of personal income in Alaska went to education than for the nation, and Alaska's pupil-teacher ratio was slightly more favorable than the U.S. average.

ECONOMY OF THE STUDY AREA

GENERAL

The Southcentral Railbelt area of Alaska is the focus of continuing substantial growth in economic activity. Construction of the trans-Alaska oil pipeline is providing the primary impetus, with impacts being felt in virtually all sectors of the economy. A continued high level of Federal Government spending coupled with substantial State spending is supporting the growth. This expansion is expected to continue for at least five to seven years, supported largely by activities of, or relating to, the petroleum industry. The following provides an indication of these recent trends for the Alaskan economy. (Unless otherwise noted, all tables and graphs in this section of the report are taken from The Alaskan Economy, Department of Commerce and Economic Development, Mid-Year Review, 1975.)

ALASKAN ECONOMIC INDICATORS

		1970	1971	1972	1973	1974	1975*
	Total Resident Population	302.4	311.0	322.1	330.4	351.2	386.3
Thousands	Labor Force	108.2	115.9	122.9	129.6	148.9	176.5
	Total Employment	98.5	103.8	110.0	115.6	134.0	160.5
	Wage & Salary Employment	93.1	98.3	104.2	109.9	128.2	154.5
	Number Unemployed	9.7	12.1	12.9	13.9	14.9	16.0
	Percent Unemployed	9.0 %	10.4 %	10.5 %	10.7 %	10.0 %	9.1%
Millions of $	Wage & Salary Payments	$1,116.2	$1,283.7	$1,422.7	$1,546.8	$2,078.0	$3,100.0
	Total Personal Income	1,412.8	1,548.3	1,697.1	1,957.8	2,398.0	3,500.0
	Alaska Gross Product	2,196.4	2,354.7	2,508.3	2,756.3	3,790.0	5,800.0

*Estimates

Source: 1970-74 Personal Income from U.S. Department of Commerce; 1970-73 Gross Product from Man in the Arctic Program, ISEGR, University of Alaska; 1974 Gross Product by Division of Economic Enterprise; 1975 Projections by Division of Economic Enterprise.

MINERAL PRODUCTION

Exploration and development activity in the mineral industry is increasing following a short slack period. A long-term trend of increasing value in mineral production continues, primarily reflecting increased product prices as shown in the following table.

MINERAL INDUSTRY INDICATORS
(Value in Thousands of Current Dollars)

Production		1971	1972	1973	1974 P
Petroleum:	Value	$257,562	$235,444	$261,877	$438,540
	Volume – 1,000 42 gal. barrels	79,494	72,893	72,323	71,540
Natural Gas:	Value	$ 17,878	$ 18,463	$ 19,483	$ 29,668
	Volume – MMCF	121,618	125,596	131,007	144,021
Sand & Gravel:	Value	$ 32,806	$ 15,214	$ 19,913	$ 24,936
	Volume – 1,000 short tons	23,817	14,187	14,999	18.740
Gold:	Value	$ 537	$ 506	$ 695	$ 1,318
	Volume – Troy ounces	13,012	8,639	7,107	8,185
Other Minerals:	Value	$ 14,040	$ 16,511	$ 26,821	$ 28,746
Total		$322,823	$286,038	$328,789	$523,208
Employment					
Petroleum Industry		2,090	1,792	1,671	2,586
All Other Minerals		340	321	296	390
Total Mining		2,430	2,113	1,967	2,976

P Preliminary

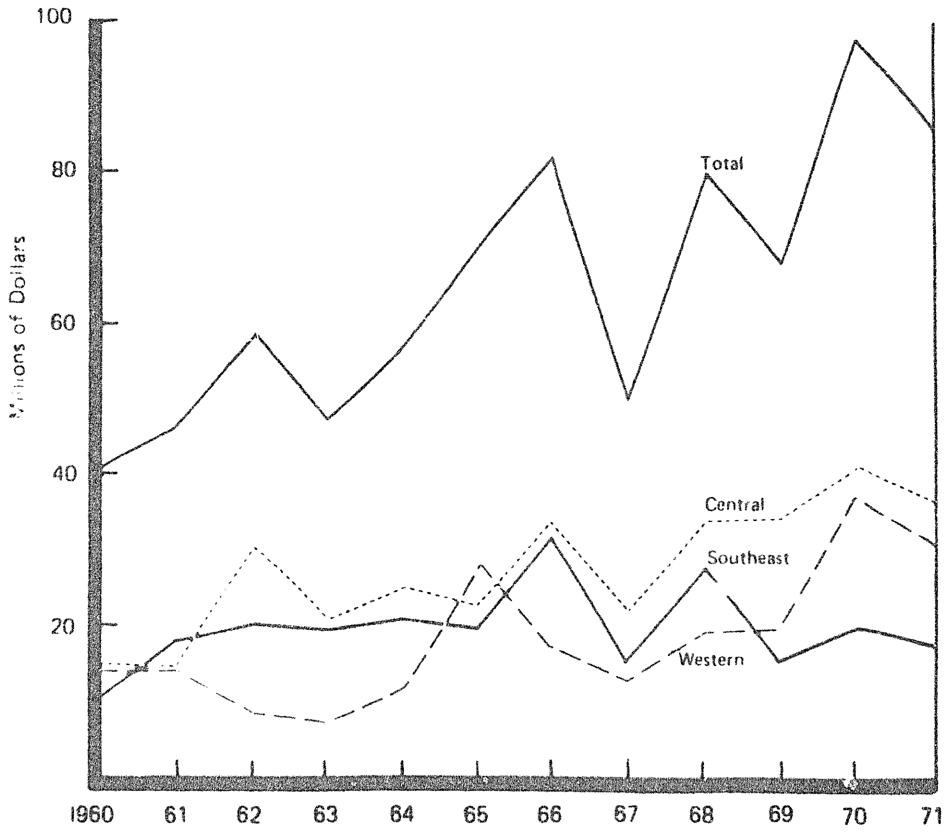
Source: U. S. Department of the Interior: Bureau of Mines, Alaska Department of Labor.

Oil production in the Cook Inlet reached its peak in 1970 and has been declining slowly since then. Continued development of proven fields is expected until completion of Alyeska's pipeline allows Prudhoe Bay oil to be produced, now projected for mid-1977. Copper, gold, and coal are the primary objectives of current hard mineral exploration activity. Despite the extensive mineral potential, the mining industry presently faces a proposed State severance tax on hard rock minerals, strict environmental constraints, and complicated land access problems linked to native land claims and Department of the Interior land withdrawals. New interest in steam coal, particularly by the Japanese, will attract investigation of coal fields in the Matanuska Valley and the Railbelt vicinity. Further exploration of the Beluga River coal fields is anticipated, accompanied by related research on refinement processes.

FISHERIES

Of the world's 150 billion pound annual fish harvest, more than 4.5 billion pounds come from the waters adjacent to Alaska. Among the states, Alaska usually ranks first in value of fish products produced, and third or fourth in terms of volume. Salmon accounts for the largest portion of the Alaskan fishing industry and the catch tends to be cyclic from year to year as suggested in the following graph.

Value to Fisherman by Region
(1960 1971)



The following table shows the size and value of the fish catch in a region that closely coincides with the study area.

CENTRAL ALASKA REGION CATCH AND GROSS VALUE TO THE FISHERMEN
1960 - 1972
(Catch in Millions of Lbs., Value in Thousands of Dollars)

	Salmon		Shellfish		Other Fish		Total	
Year	Lbs.	Value	Lbs.	Value	Lbs.	Value	Lbs.	Value
1960	84.2	$11,734	36.1	$ 2,789	6.1	$ 603	126.3	$15,126
1961	77.0	9,463	54.5	4,380	4.1	495	135.5	14,338
1962	144.8	21,851	63.5	5,663	9.4	2,502	217.7	30,015
1963	93.3	11,906	70.6	6,409	11.1	1,944	175.0	20,259
1964	146.4	16,958	64.7	6,147	8.2	1,314	219.3	24,419
1965	73.2	10,178	114.1	10,691	7.9	1,383	195.2	22,252
1966	116.6	17,163	144.3	13,142	15.6	3,117	276.6	33,421
1967	47.6	9,767	129.8	12,175	13.7	1,645	191.1	21,708
1968	111.8	17,680	90.8	14,492	12.7	1,546	215.3	33,719
1969	121.3	19,802	85.7	10,296	18.4	3,680	225.4	33,777
1970	140.1	23,774	13.6	12,025	15.6	4,882	269.3	40,681
1971	109.9	19,465	129.8	12,353	19.0	4,840	256.6	36,658
1972	73.3	16,344	140.9	17,049	19.6	9,380	233.8	44,773

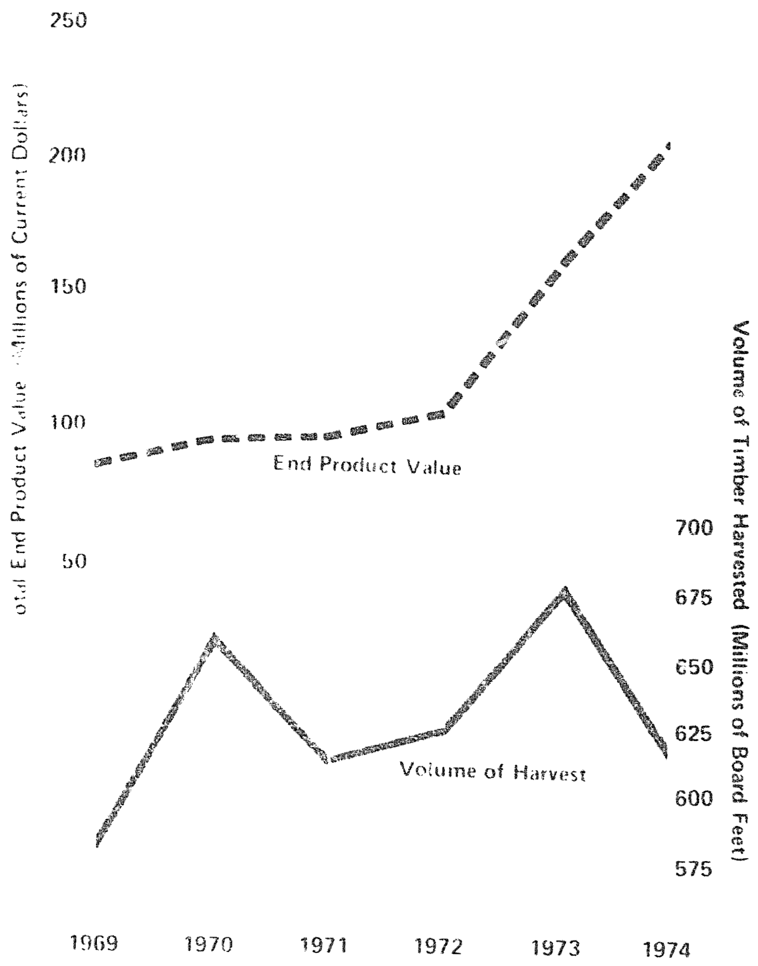
Source: Alaska Department of Fish and Game

More recently, the fishery industry has experienced several difficult and unstable years. The fishing industry was plagued by poor runs of pink salmon statewide and the continuing decline of the Bristol Bay fishery. Consequently, the total 1975 catch was at about the same level as the previous year's poor harvest. The current depressed condition of Alaska's salmon fisheries is considered a temporary phenomenon. Prospects for other fish varieties are mixed, dependent upon, among other things, the possible establishment of a 200-mile exclusive fisheries zone and harvesting at a rate that can be sustained. Alaska bottomfish potential appears to be high.

FOREST PRODUCTS

In general, Alaska's annual harvest of timber has increased steadily since 1959. National forest lands provided over 85 percent of total timber cut each year. About one-third of Alaska's 365 million acres supports forest cover of varying density, size, and type. One-fourth of this forested area is considered to have present or future commercial development potential. This includes present production within the study area west of Cook Inlet, near Tyonek, and in the Chugach National Forest. In volume of timber processed, the vast majority of production is presently in the Tongass and Chugach National Forests. The major product of the timber harvest is wood pulp. A sharp decline in the timber harvest occurred in 1974 due primarily to a depressed market for sawn products in Japan. The unusually healthy pulp segment more than offset the poor performance of the lumber sector, however. The following graph indicates recent industry trends.

TIMBER HARVEST



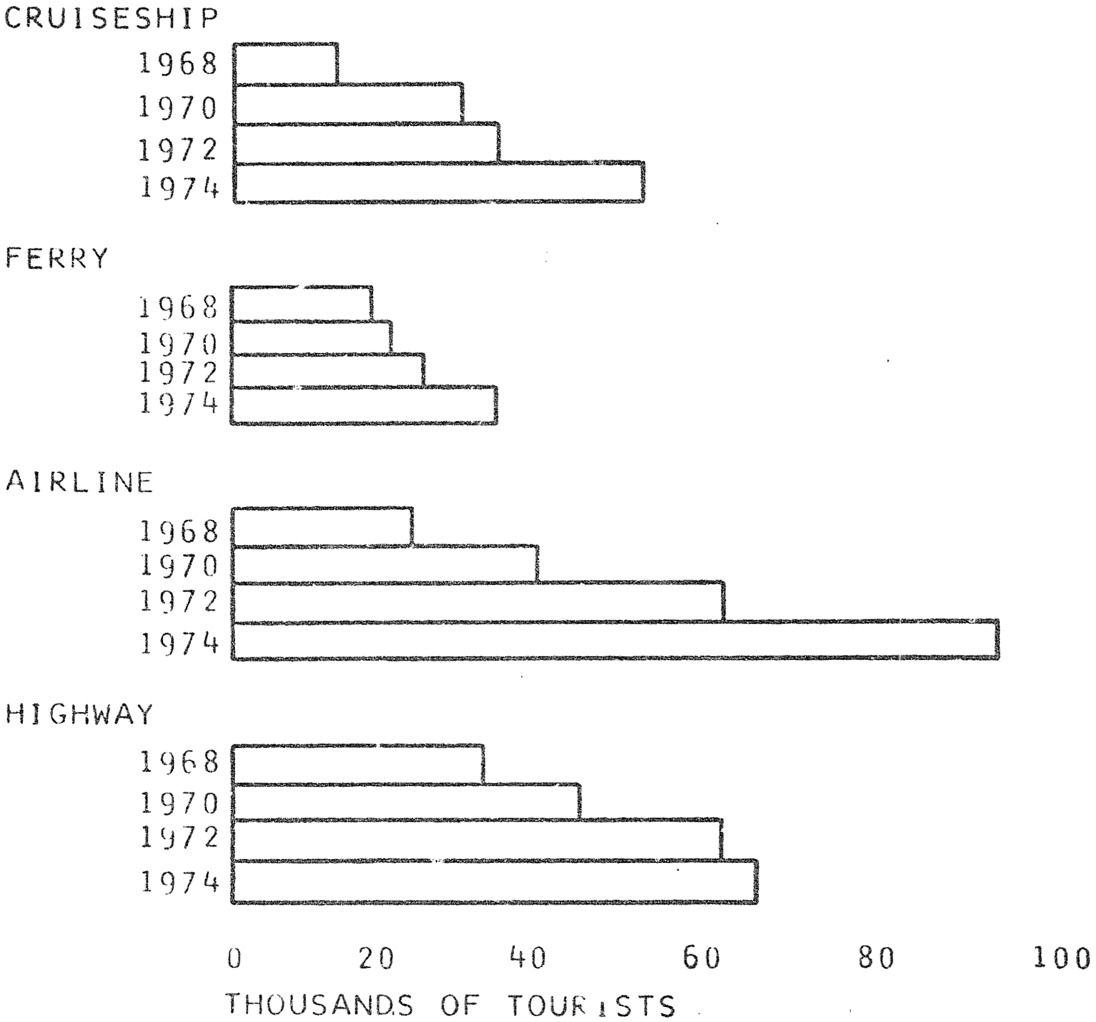
Sources: U.S. Forest Service, Alaska Division of Lands, U.S. Bureau of Indian Affairs, U.S. Bureau of Land Management, and U.S. Department of Commerce

Despite the present slowdown, the Alaska Department of Economic Development predicts new markets in Japan and steady growth in Alaska's forest products industry.

TOURISM

Tourism in Alaska is a major industry with tourist volume increasing at a rate of almost 15 percent per year since 1964. Approximately 240,000 non-resident pleasure travelers entered Alaska in 1974. Tourism should continue to grow as transportation and facilities are improved. The following graph indicates recent trends.

NUMBER OF TOURISTS ENTERING ALASKA



SOURCE: ALASKA DIVISION OF TOURISM.

As the transportation hub of the bulk of Alaska, the Anchorage area realizes the major share of this activity.

OTHER INDUSTRIES

Other industries have in general paralleled the growth in the primary industries. Contract construction is especially healthy due to pipeline construction activities, and the future would appear to depend on continued resource development in the State. Consistent growth over the last decade has occurred in the trade and service industries, while agriculture production has been relatively static. Recent changes to more efficient and larger farms have put Alaskan agriculture in a more solid position, and the potentially tillable land is extensive. The government sector, already the largest contributor to the Alaskan economy, continues to grow rapidly.

PRESENT POWER REQUIREMENTS

To sustain the current population and level of economic activity in the Southcentral Railbelt area, power is provided by several utility systems as well as industrial and national defense power systems. The following table provides a summary of existing generating capacity as of mid-1974.

SUMMARY OF EXISTING GENERATING CAPACITY

	Installed Capacity - 1000 kw				
	Hydro	Diesel IC	Gas Turbine	Steam Turbine	Total
Anchorage-Cook Inlet Area:					
Utility System	45.0	13.5	341.7	14.5	414.8
National Defense		9.3		49.5	58.8
Industrial System		10.1	2.3		12.4
Subtotal	45.0	32.9	344.0	64.0	486.0
Fairbanks-Tanana Valley Area:					
Utility System		32.1	42.1	53.5	127.7
National Defense		14.9	63.0		77.9
Subtotal		47.0	105.1	53.5	205.6
Valdez and Glennallen		6.2			6.2

Notes: The majority of the diesel generation is in standby status except at Valdez and Glennallen.

Source: 1974 Alaska Power Survey, Technical Advisory Report, Resources and Electric Power Generation, Appendix A, and Alaska Electric Power Statistics, 1960-1973, APA.

The Anchorage-Cook Inlet area had a total installed capacity of 414.8 MW in 1974. Natural gas-fired turbines were the predominant energy source with 341.7 MW of installed capacity. Hydroelectric capacity of 45 MW was available from two projects, Elkutna and Cooper Lakes. Steam turbines comprised 14.5 MW of capacity and diesel generation, mostly in standby service, accounted for the remaining 13.5 MW.

The Fairbanks-Tanana Valley area utilities had a total installed capacity of 127.7 MW in 1974. Steam turbines provided the largest block of power in the area with an installed capacity of 53.5 MW. Gas turbine generation (oil-fired) provided 42.1 MW of power, and diesel generators contributed 32.1 MW to the area.

The energy needs of the Southcentral Railbelt area are estimated by the Alaska Power Administration to more than double by 1985 from the present 2 billion kilowatt-hours to 5.5 billion kilowatt-hours. By the year 2000, the energy requirement is estimated to reach 15 billion kilowatt-hours. The following section is a discussion of these energy need projections as well as of the energy use and development assumptions upon which they are based.

PROJECTED ENERGY NEEDS

In its marketability analysis, Alaska Power Administration prepared Railbelt area load projections for 1980, 1990, and 2000 under three different growth scenarios. These projections are based on the 1974 Alaska Power Survey, adjusted to account for more recent data, current regional and sectional trends in energy and power use, and to eliminate loads which would be too remote to be served from a Railbelt transmission system.

The use of a range of projections is necessitated by the wide variation possible in future population and economic growth in Alaska due to uncertainty regarding the controlling factors of cost, conservation technologies, available energy sources, types of Alaskan development, and national energy policy. All projections assume saturation levels for many energy uses will be reached and that rates of increase for most individual uses will decline during the period of study. This reflects assumed effects of major efforts to increase efficiencies and conserve energy for all uses.

In accordance with APA's recommendations, the projections based on the mid-range growth scenario were adopted for this study. The mid-range projection is based on utility system growth rates of 12.4 percent for 1974-1980, 7 percent for 1980-1990, and 6 percent for 1990-2000. National defense requirements are based on a 1-percent growth rate and industrial requirements presume a gradual expansion of facilities.

The following table summarizes the mid-range load projections for the Railbelt area.

ESTIMATED RAILBELT AREA POWER REQUIREMENTS - MID-RANGE GROWTH RATE

	1974 Actual		1980		1990		2000	
	Peak Demand 1000 kW	Annual Energy 10^6 kWh	Peak Demand 1000 kW	Annual Energy 10^6 kWh	Peak Demand 1000 kW	Annual Energy 10^6 kWh	Peak Demand 1000 kW	Annual Energy 10^6 kWh
Utilities								
Anchorage	284	1305	590	2580	1190	5210	2510	9420
Fairbanks	83	330	150	660	290	1270	510	2230
Total	367	1635	740	3240	1480	6480	2660	11,650
National Defense								
Anchorage	33	155	35	170	40	190	45	220
Fairbanks	41	197	45	220	50	240	55	260
Total	74	352	80	390	90	430	100	480
Industrial								
Anchorage	10	45	50	350	100	710	410	2870
Fairbanks 1/	--	--	--	---	---	---	---	----
Total	10	45	50	350	100	710	410	2870
Total								
Anchorage	327	1505	675	3100	1330	6110	2605	12,510
Fairbanks	124	527	195	880	340	1510	565	2,490
Total	451	2032	870	3980	1670	7620	3170	15,000

1/ Rounds to less than 10 MW for all years.

APA POWER REQUIREMENT PROJECTION METHODOLOGY

Several basic assumptions underlie Alaska Power Administration's analysis. It is assumed that boom conditions will give way to orderly expansion in the 1980's and 1990's, with an annual growth rate for electrical energy after 1980 similar to that experienced over the last decade in the rest of the country--between 6 and 7 percent. The presumption is also made that, barring major changes in technology that favor other forms of energy use, electrical power production will need to anticipate and keep pace with the overall growth in population and production.

APA's power requirement projections are a composite of three sectors which were analyzed separately. The first is composed of utility system requirements, which includes residential, commercial, light industrial, and industrial support services requirements. The second sector examined is national defense requirements, and finally industrial requirements for resource extraction and processing, new energy-intensive industries, and heavy manufacturing are explored.

Utility System Requirements: Utility system load estimates were compiled for existing individual systems for the years 1980 and 1990; these were then extended through 1990 to the year 2000. The mid-range extends the growth rate to 1980 at about 12 percent, somewhat less than the past decade's historical rate of 14 percent for the Railbelt area. Higher and lower range utility load estimates for 1980 assume about 20 percent more and less growth than the mid-range estimate. It is then assumed that somewhat lower growth rates would prevail in subsequent decades. Growth rates of 9 percent in the 1980's and 8 percent in the 1990's are considered to represent fairly rapid development of the Alaska economy in those two decades. The lower range estimates are considered to represent fairly modest growth.

ASSUMED ANNUAL UTILITY GROWTH RATES IN PERCENT

ESTIMATE:	1974-1980	1980-1990	1990-2000
Higher Range	14	9	8
Likely Mid-range	12	7	6
Lower Range	11	6	4

National Defense Requirements: Future power requirements for national defense facilities were premised on the 1974 power use for the major bases and an assumed future growth of approximately one percent per year. These estimates are lower than presented in the 1974 Alaska Power Survey, which assumed a growth rate of 1.7 percent.

Industrial Requirements: Industrial use (as defined by APA for purposes of this analysis) accounts for about 2 percent of the Railbelt area's 1974 total power requirement and is expected to grow to 19 percent in 2000, according to the mid-range projection. This remains well below the industrial share nationwide. The industrial requirement is the most speculative aspect of the projection because it is very difficult to foresee the timing of new facilities.

The analysis assumes a high probability of major new mineral production and processing. Also expected are significant further developments in timber processing, and it is assumed that Alaska energy and the availability of other resources such as water, industrial sites, and port sites will attract energy-intensive industries. The primary data source for the industrial sector projections was a 1973 study by the Alaska Department of Economic Development. That study included review and estimates of power requirements for Alaska's fishery, forest products, petroleum, natural gas, coal, and other mineral industries, all premised on significant identified resource potentials and on power needs for similar developments elsewhere. Several qualifying assumptions were made by APA to adapt this study for use in the marketability analysis.

1. Power requirements for fish processing industries and support services for industrial development are not included, having already been addressed in the "utility requirement" portion of the analysis.

2. Estimated mineral industry loads (except for petroleum and related industry) for the year 2000 were adopted as APA's "higher range" estimate, with estimates for 1980 and 1990, reflecting anticipated minimum lead times for developing the resources involved. The mid-range estimate assumes a 10-year deferral of the Department of Economic Development's projected growth scenario, and the lower range estimate a 20-year deferral.

3. Power requirements assumed for Alaska petroleum and petrochemical industries are smaller than estimates in the reference study, based on expectations that most Alaska oil and gas production would be exported during the period of the survey. For example, the mid-range estimate assumes 7 percent of petroleum industry loads estimated in the reference study.

4. A somewhat slower pace of development was assumed for forest products industries.

All of the above qualifying assumptions, with the exception of No. 1 which had a neutral effect, were downward adjustments, decreasing the estimates of the basic study. Specific industrial development assumed for the study is presented in Section G, Appendix 1. Only planned expansions to existing facilities and realistically identifiable new industry closely tied to proven resource capabilities were assumed.

SUMMARY

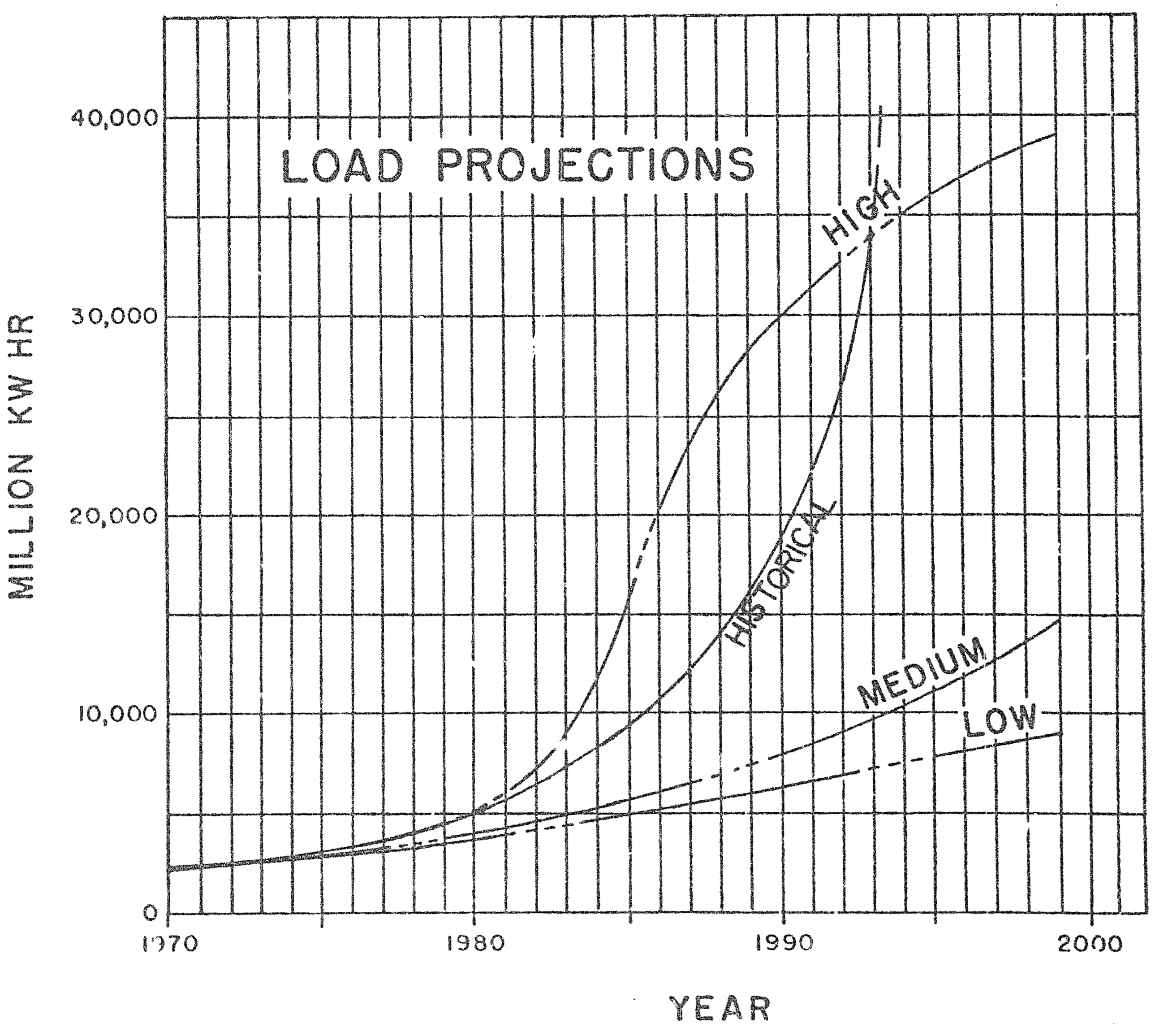
When combined, the composite annual growth rates for the projected power requirements are as indicated in the following table.

COMPOSITE ANNUAL GROWTH RATES FOR ELECTRIC POWER
(Percent)

ESTIMATE:	1974-1980	1980-1990	1990-2000
Higher Range	12.4	20.2 1/	3.0
Likely Mid-range	9.6	6.7	7.0
Lower Range	7.5	5.8	4.0

1/ This high rate is caused by the assumed introduction of a 2500 MW nuclear fuel enrichment plant as an example of a possible large industrial load. Without this load, the 1980-1990 growth rate would be 9.3 percent and the following decade's would be 6.6 percent. No such load is assumed for the mid and lower range projections.

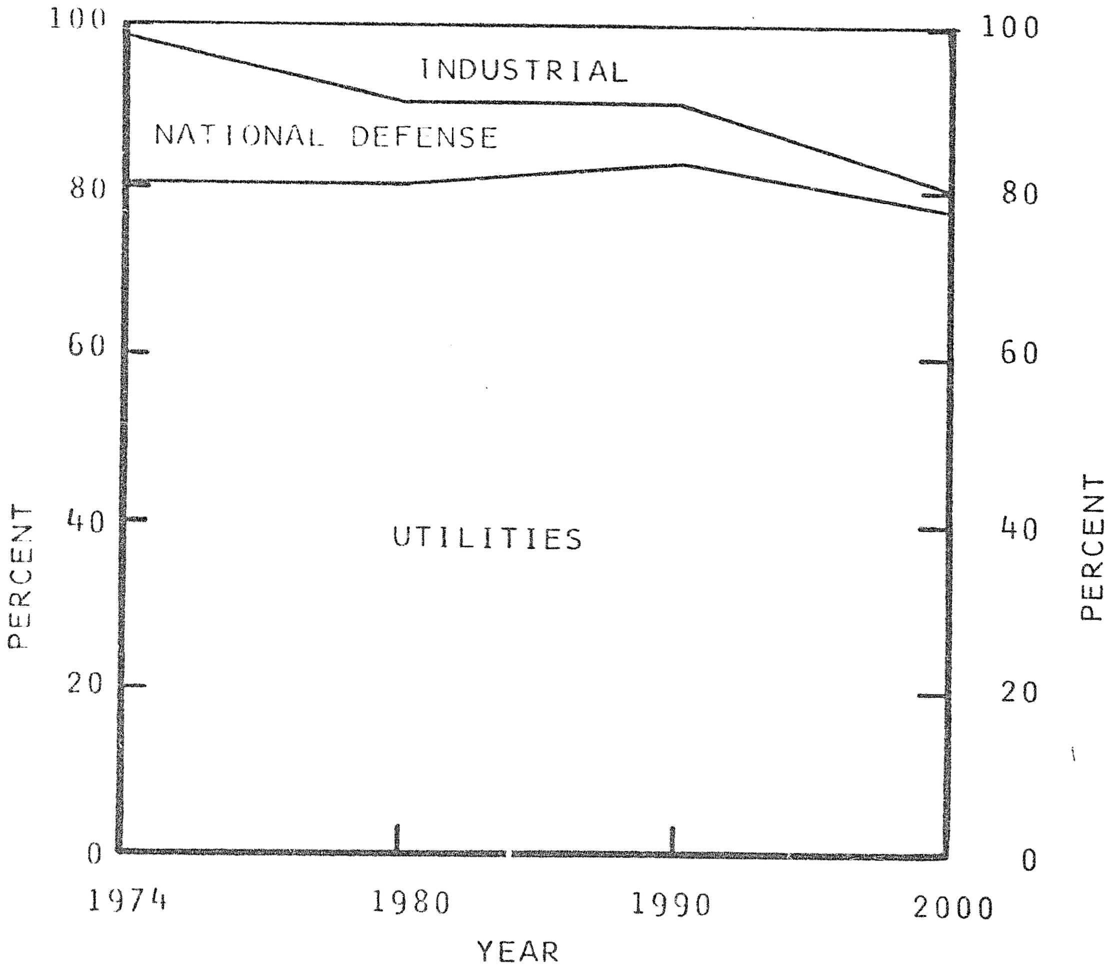
The three growth projections are displayed in the following graph and compared to the last decade's historical growth rate of 14 percent projected to the year 2000.



PROJECTED
ENERGY DEMAND
SOUTHCENTRAL RAILBELT

The graph below depicts the relative shares through time of the three demand sectors analyzed by APA. Utility system requirements include residential, commercial, light industrial, and industrial support services needs. Industrial requirements are comprised of resource extraction and processing, new energy-intensive industries, and heavy manufacturing.

COMPOSITION OF ENERGY REQUIREMENTS THROUGH TIME
(MID-RANGE ESTIMATES)



This graph clearly indicates that the prime determinants of future energy needs are expected to continue to be residential, commercial, and light industrial uses of energy. The energy use in these sectors is primarily determined by energy use habits, population, and economic activity.

Energy Use Assumptions: APA has assumed substantial savings in energy consumption due to increased efficiency and conservation in energy use. Both of these effects are expected to result from imminent and probable future increases in Alaska energy costs.

Population Assumptions: APA's population assumptions, based on a wide range of State and Federal agency, as well as financial and academic institution projections, tend to be somewhat conservative when compared to the most recent projections which more adequately incorporate existing economic realities. For instance, the Institute of Social, Economic, and Government Research of the University of Alaska, employing a recently formulated econometric model (the MAP model) and the most likely development scenario, predicts an annual population growth rate of about 5 percent for the Railbelt area through 1990. Current MAP model as well as National Bank of Alaska (NBA) population estimates both exceed those earlier projections that were cited in the 1974 Alaska Power Survey. The following table compares population projections based on a continuation of 1960-1970 annual growth of 3 percent with MAP and OBERS estimates. OBERS projections are prepared by the U.S. Departments of Commerce and Agriculture for the U.S. Water Resources Council.

STATE POPULATION ESTIMATES (1000's)

	1960	1970	1975	1980	1990	2000
Actual	226	302	386 (est.)			
3 percent Growth (Alaska Power Survey)				410	550	740
MAP				47[illegible]	738	
NBA				500		
OBERS (Series E)				333	391	438

OBERS projections are inappropriate for use in this study as a basis of population estimation in Alaska as evidenced by the fact that the actual 1975 Alaskan population almost equals the 1990 OBERS projection.

Economic Activity Assumptions: With regard to economic activity, the MAP model agrees with APA's assumption of steady economic growth following the present boom period. To 1980, gross product is projected by the MAP model to increase at an annual rate of 7.0 percent in the Anchorage-Fairbanks area, followed in the next decade by an annual growth rate of 6.0 percent. National Bank of Alaska considers this a somewhat conservative estimate.

Not all of the subregions will share equally in this growth. The Anchorage-Cook Inlet subregion has been the focal point for most of the State's growth in terms of population, business, services, and industry since World War II. Because of its central role in business, commerce, and government, the Anchorage area is directly influenced by economic activity elsewhere in the State. Present and proposed activities indicate a high probability of rapid growth in the Cook Inlet area for the foreseeable future. Much of this activity is related to oil and natural gas development to include expansion of refineries at Kenai, proposed LNG exports to the continental United States, and probable additional offshore oil and gas production. The area will continue to serve as the transportation hub for most of Alaska and the proposed capital relocation would provide additional impetus for growth.

Fairbanks, in the Tanana subregion, is Alaska's second largest city, the trade center for much of Alaska's interior, service center for two major military bases and site of the University of Alaska. Currently, it is in the midst of a major boom connected with the construction of the Alyeska pipeline. It is generally felt that postpipeline growth in the Fairbanks area will be at a slower pace than that of the Cook Inlet subregion. Major future resource developments in the interior and north slope would have direct impact on the Fairbanks economy.

Like Fairbanks, the two major load centers of the Gulf of Alaska subregion, Valdez and Glennallen are heavily impacted by pipeline construction. Longer range prospects indicate a more stable economy associated with pipeline and terminal operations and with recreation.

Institutional Considerations: Energy projections for Alaska are of necessity more speculative than those for more developed areas in the rest of the country. This is due to the present relatively small population and economic base and the very substantial influence that political decisions will have regarding development of Alaska. National energy policy, final land disposition, and capital relocation are examples of institutional constraints which may significantly alter future energy requirements. It is the effect of such influences that largely accounts for the wide range in energy projections.

CONCLUSIONS

The higher range projection provided by APA is comprised in the year 2000 of over 50 percent industrial use. This magnitude of heavy industrial development is deemed too speculative to serve as a basis for energy planning at this time. The lower range projection, on the other hand, incorporates a composite growth rate for the remainder of the 1970's too far removed from the present actual annual rate of increase to be accepted as a best estimate of future energy use. In general, the broad population and economic trends as well as the more specific energy use and economic development assumptions of the mid-range estimate reflect a realistic balancing of recent experience in Alaskan energy consumption growth with expected future development and more efficient use of energy. For these reasons, the mid-range energy requirement projection furnished by the Alaska Power Administration has been adopted as the basis for project planning.

It is recognized that by making assumptions about future population and economic growth and then providing energy sufficient to sustain such growth, the initial projections may become a self-fulfilling prophecy. By presuming that energy needs must be met, the opportunity to use the provision of power as a tool to direct growth toward socially desirable goals is foregone. In the absence, however, of any such generally accepted growth goals, it seems highly presumptuous to do otherwise than plan so as to satisfy the energy needs required to sustain that level of future development deemed most likely.

PROBLEMS AND NEEDS

Problems and needs of the Railbelt area which are associated with water and related land resource development cover a broad range of economic, environmental, and social concerns. Specific items identified from expressions of governmental agencies, of industry, of special interest organizations, and of private citizens include:

The projected need for increased supplies of electrical energy,

A need for reduction or prevention of flood damages,

A need for improved small boat and deep draft navigation conditions,

A need for increased municipal water supply,

A need for future supplies of irrigation water,

A need for reduction and prevention of air pollution in Fairbanks and Anchorage,

The need to conserve and enhance fish and wildlife resources,

The need for additional recreational opportunities for the population,

The preservation and maintenance of the "Alaskan way-of-life", including prevention of further population growth, prevention of additional industrialization, and cessation of expansion of urban areas,

The national desire to achieve energy independence from foreign sources, and

The national desire to conserve nonrenewable resources.

PLAN FORMULATION

Plan formulation involves a systematic process of analyzing needs and problems, establishing study objectives, and developing and evaluating alternative plans for resource management. Plan formulation is guided by Corps of Engineers policy on multiobjective planning, in accordance with legislative and executive authorities provided by the National Environmental Policy Act (NEPA), Public Law 91-190, 1 January 1970; Section 122, River and Harbor and Flood Control Act of 1970, Public Law 91-611, 31 December 1970; Principles and Standards for Planning Water and Related Land Resources, Water Resources Council, 38 FR 24778-24869, 10 September 1973; and various other statutes. Under these guidelines, the basic water resource planning objectives are, co-equally, National Economic Development (NED) and Environmental Quality (EQ), with consideration being given to social well-being and regional development.

STUDY OBJECTIVES

The study objectives derive from the problems and needs that are specific to the study area and can be reasonably addressed within the framework of the study authority and purpose. The objectives selected for this study are:

To provide additional electrical energy to the Railbelt area as directed by the authorizing resolution;

To control flooding and reduce flood damages in the Railbelt area;

To reduce or prevent air pollution in the Railbelt area;

To preserve, conserve, or enhance fish and wildlife in the Railbelt area;

To provide increased recreational opportunities within the Railbelt area;

To conserve nonrenewable resources of the nation; and

To contribute toward national energy independence.

Navigation improvements are not compatible with any solution aimed at the other needs.

The needs for municipal water supply can be more economically solved by means that are independent of the majority of the other water resource development needs.

The need for irrigation water presumes a level of agricultural development which is not now planned or foreseeable.

To preserve the Alaskan lifestyle by halting growth of all forms at the present level is beyond the authority of the Corps of Engineers and is thus not a study objective.

POSSIBLE SOLUTIONS

The following alternative methods of satisfying the primary study objective, the provision of electric power for the Railbelt area, were considered as possible solutions:

Alternative Sources of Power

- Coal
- Natural gas and oil
- Nuclear
- Geothermal
- Solar
- Wind and tide
- Wood
- Intertie with sources elsewhere
- Solid waste
- Hydroelectric
  - Yukon River--Rampart Dam
  - Copper River--Wood Canyon Dam
  - Chakachatna River--Chakachamna Dam
  - Bradley River--Bradley Lake Dam
  - Susitna River
    - Single Dams
      - Devil Canyon
      - Devil Canyon High (Susitna I)
      - Watana
    - Two-Dam Systems
      - Devil Canyon-Denali
      - Devil Canyon-Watana
    - Three-Dam System
      - Devil Canyon-Watana-Vee
    - Four-Dam Systems
      - USBR: Devil Canyon-Watana-Vee-Denali
      - Kaiser: Susitna I, II, III-Denali

These alternatives were screened on the basis of preliminary estimates of response to the basic water resource planning objectives of NED (economic viability) and EQ (contributions to environmental quality). Within the NED considerations, in addition to the purely economic factors, such items as technical feasibility (can it be done with existing technology?) and scale (does it do too little or too much?) were considered important. Within the EQ considerations, in addition to positive contributions to environmental factors, a lack of adverse effects was considered significant. The intent and effect of this brief screening was to rule out impracticable and marginal alternatives leaving a small number of the better possible solutions to be studied and evaluated in detail. The following discussions summarize the preliminary evaluation.

Coal: Coal is the most abundant fossil fuel in the nation. Southcentral Alaska has two extensive deposits. The Beluga River area northwest of Cook Inlet contains coal reserves of at least 2.3 billion tons or, energy-wise, an equivalent of almost 7 billion barrels of oil. Development of Beluga coals would enhance possibilities for coal-fired power generation at reasonable cost. Coal resources in the Nenana fields in the Southcentral Railbelt, south of Fairbanks near Healy, Alaska, are even more extensive than the Beluga River reserves, totaling at least 7 billion tons.

In many cases, the major obstacle to increased coal usage is the problem of removing the high sulfur content in order to meet air quality standards when the coal is burned. Other problems include strip mining, with associated environmental impacts, such as surface disturbance, waste material disposal, and chemically active water discharge; post-mining restoration; and transportation of the coal. The Beluga coals have low amounts of sulfur, but have high ash and water content. Considerable refining would be needed for use in power generation.

The coal alternative could be available on about the same timeframe as other major new power sources, such as hydropower and, possibly, nuclear power. Baseload thermal plants could probably be utilized in the Railbelt area by the 1980's. Coal-fired plants should also be given consideration in remote areas which could be supplied by water transportation.

In the absence of major hydro development or the discovery of additional gas reserves, the Railbelt power system would probably shift from oil and gas-fired power units to coal as their principal energy source. The coal plants would either be conventional steam or steam and gas turbine units located near the Beluga and Nenana coal fields. It is concluded that coal is a technically feasible and economically viable alternative with certain probable adverse environmental effects. Further study and evaluation of this alternative is justified.

Natural Gas and Oil: Alaska power systems now depend on oil and gas for about 60 percent of total energy production, and by 1980 about 90 percent of the State's electric energy will come from these fuels. Estimated 1972 fuel use for Alaska's power systems included 1.4 million barrels of oil and 16 billion cubic feet of natural gas. The use would increase to about 26 million barrels of oil and 134 billion cubic feet of natural gas (if available) annually by the year 2000 in meeting the mid-range consumption level estimates.

Cook Inlet natural gas has provided low cost power benefits for the surrounding area in the recent past, and with substantial reserves under contract, should handle area power requirements for several more years. However, even if additional reserves are found to meet future demands, it appears reasonable to assume that there will be substantial increases in costs for oil and gas supplied as U.S. domestic reserves decline, worldwide demand increases, and foreign oil prices remain high. There is no longer any reason to anticipate that Alaskan oil and gas will provide an abundant, cheap energy source for the long term. These fuels will be expensive, if for no other reason than pressures to export the resources to areas where higher prices can be obtained for their use in petrochemical industries.

Cook Inlet natural gas is a clean fuel. Few serious air pollution problems exist for gas-fired units; however, the amount of gas reserves is not known at this time. Gas turbine exhaust is noisy, although modern noise suppression equipment can reduce this impact at a price. Energy conservation aspects of gas-fired units may become significant because existing gas turbines have low efficiencies and emit visible water vapor emissions during the colder winter months. Also, nitrogen emissions could be of significant concern for the very large gas-fired plants which would be needed.

It is concluded that natural gas and oil as a power source is feasible for the near future. However, there is serious doubt as to the continued availability of the base resource and as to the continuation of economic advantage it now enjoys. There appears to be some environmental advantages to the continued use of natural gas and/or oil, but not of an apparent magnitude to be overriding to the supply-price considerations. Further study of this alternative is not deemed justified for this report.

Nuclear Power: The use of nuclear power as a commercial electrical energy source for the nation is expected to increase considerably by the year 1985. Adverse environmental impacts are associated with surface and subsurface mining of uranium, changes in land use, disposal of waste heat, risk of accidents, and safe disposal of highly radioactive wastes. In spite of these factors, more than 50 percent of the electrical power of the nation is expected to be generated by nuclear power by the year 2000. By that time, breeder plants, which produce additional fuel while they produce power, will hopefully be available to take over a larger share of the production of electricity. Possibly at some time in the next century, nuclear fission plants and proposed nuclear breeder plants will be replaced by nuclear fusion reactors and by central generating stations running on solar power.

Nuclear power should be considered a likely long-range source of baseload power for the Railbelt area, but is generally considered a distant option because of size of power markets, cost, and environmental factors. Further study of this alternative is not deemed justified for this report.

Geothermal: Geothermal resources may eventually provide significant power generation in Alaska; the Southcentral Railbelt area has substantial geothermal potential. Some of the possible problems associated with the generation of electrical power from geothermal resources include siting of facilities, brine disposal, and corrosion. This resource could also provide usable side products such as heat, water, and chemicals. This source of energy is not considered a reasonable short-term alternative to other more proven types of power generation because of the relatively primitive level of present technological development and high costs. Further study of this alternative is not deemed justified for this report.

Solar: The radiant heat of the sun is another renewable source of energy that has considerable potential for generating power in the nation and the world. Use of solar energy to produce electrical power on a large scale is not presently feasible for the lack of the technology to generate and to store large amounts of electricity produced by the sun's radiation. A major disadvantage wherever such a development is pursued will be the large land area required for reflector installation to provide usable amounts of power and thus the large environmental disturbances inherent in such a change in land use. Another disadvantage, especially in Alaska, will be that during the winter, when demand for electrical power is greatest, the sun is either absent from or at best a brief visitor to local skies. Further study of this alternative is not deemed justified for this report.

Wind and Tidal: Research and development proposals for wind generators should improve future capabilities of wind-powered electrical generating systems. With increased diesel fuel costs, wind-generated electrical power is a possible alternative power source for remote areas with small loads. The alternative is not considered feasible for provision of large amounts of energy at this time.

The Cook Inlet region of Alaska experiences one of the larger tidal ranges of the world, giving it a potential for the generation of electrical energy from a low head reversible hydro plant. However, such an installation would require a low dam spanning the full width of the Inlet, a massive cost item in itself, as well as a deep-draft lock system to allow commercial vessel access to the Anchorage port. The dam would change the entire flow regime of Cook Inlet with a significant potential for extensive adverse efforts on major ecosystems. Additional major effects would include intensified ice pack conditions in the upstream pool with potential for significant adverse impacts on the Anchorage waterfront. Further study of either of these alternatives is not deemed justified for this report.

Wood: In parts of southeastern Alaska, wood is used to fire steam-generating powerplants. Alaska does have vast forest reserves that could be used; however, these same trees have far higher and better alternative uses in wood, paper, and other industries. In addition, the esthetic, ecological, and environmental impacts of the large harvests necessary to allow production of large amounts of energy appear to be massive. Further study of this alternative is not deemed justified for the report.

Intertie: Instead of producing the required power in Alaska, excess power from Canada and/or the "Lower 48" could be imported by a transmission system interconnecting with the sources. However, there is no evident excess of power available to make such a development feasible. Further study of this alternative is not deemed justified for this report.

Solid Waste: The use of solid wastes was proposed by the Alaska Center for the Environment as an alternative source of energy at the intermediate public meeting held in Anchorage on 29 May 1975. The supply of solid wastes in the Anchorage area is projected to reach 500,000 tons annually by the year 2000. Even if all of the waste was combustible and had a heat value equivalent to coal, neither of which is factual, the power produced would be less than 10 percent of the projected need. Further study of this alternative is not deemed justified for this report.

Hydropower: The reconnaissance report on potential development in the State of Alaska made in 1948 by the U.S. Bureau of Reclamation, included hundreds of potential power development sites located throughout the five study regions of the State: Southeast; Southcentral; Yukon-Kuskokwim; Seward Peninsula; and Arctic. The two largest market areas for power are located in the southcentral region, particularly the Anchorage-Cook Inlet area, and the Fairbanks-Tanana Valley area. The large amount of the available renewable water resource which could produce electric power has excellent potential to answer the energy needs of the Southcentral Railbelt area.

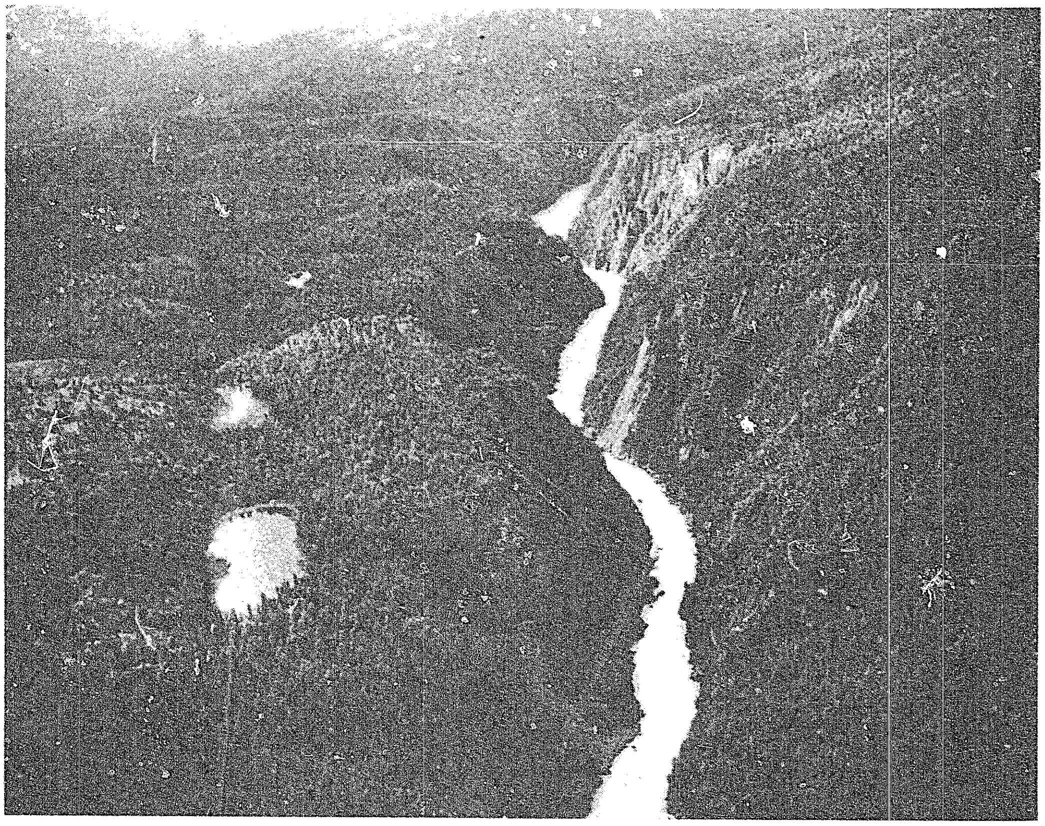
Yukon River-Rampart Canyon: The proposed site for the Rampart Canyon Dam is on the Yukon River, approximately 140 miles northwest of Fairbanks, Alaska. The project has one of the largest hydroelectric potentials in North America. The plan would include a reservoir with a water surface area of approximately 10,600 square miles, a maximum length of 280 miles, and a maximum width of about 80 miles. The project would provide firm annual energy of 34.2 billion kilowatt-hours (the energy equivalent of over 58 million barrels of oil per year). However, the projected adverse environmental impacts on fish and wildlife in the Yukon Flats are of such magnitude as to rule out project authorization up to this time. This alternative far exceeds the projected power needs of the Railbelt area for several decades. Because of the excess scale and the probable magnitude of the environmental impacts, further study of this alternative is not deemed justified for this report.

Copper River-Wood Canyon Dam: The proposed site for the Wood Canyon Dam is about 85 miles above the mouth of the Copper River in the Chugach Mountains of southcentral Alaska. A "high dam" proposal would develop firm annual energy of 21.9 billion kilowatt-hours. A "low dam" plan would provide 10.3 billion kilowatt-hours of firm annual energy.

The construction of either dam at Wood Canyon would force relocation of two communities and would create serious environmental problems affecting both fish and wildlife values, especially to the large salmon runs on the Copper River. Unless the problem posed to migrating salmon could be solved satisfactorily, the project would have severe adverse effect on the major commercial fishing industry in a wide area of the Gulf of Alaska. Further study of this alternative is not deemed justified for this report.

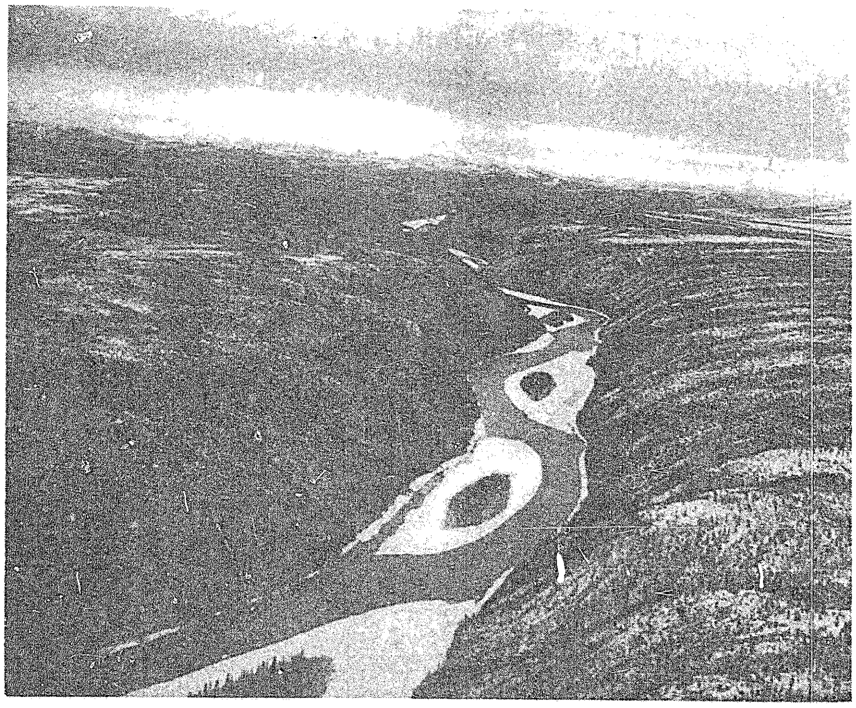
Chakachatna River-Chakachamna Dam: The site for the proposed Chakachamna Dam is located on the Chakachatna River which drains into the west side of Cook Inlet approximately 65 miles west of Anchorage. The facility would generate 1.6 billion kilowatt-hours of firm annual energy. The project would require the erection of additional transmission facilities over difficult terrain to tie into a Southcentral Railbelt transmission system and the construction of a costly 11-mile tunnel for power generation. The adverse environmental impact would be substantially less than from many proposed Alaskan hydroelectric projects. This alternative provides only a small portion of the projected energy needs. Although development at a later date to supplement other energy sources might be warranted, further study of this alternative is not deemed justified for this report.

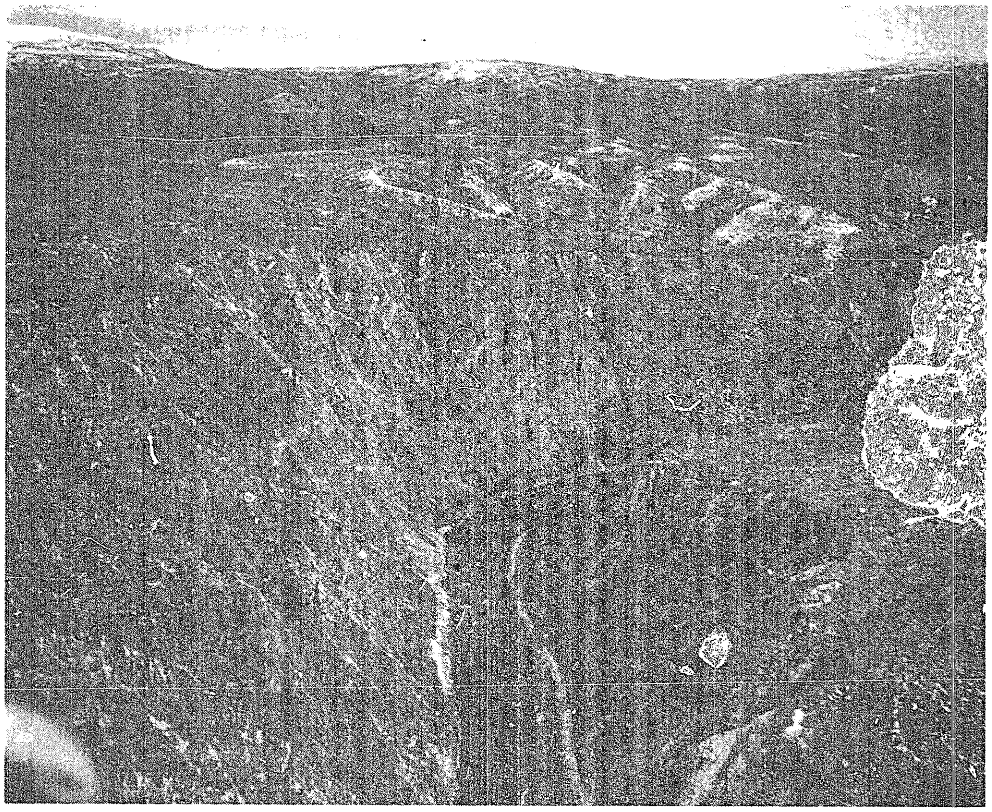
Bradley River-Bradley Lake Dam: The site for this proposed hydroelectric project is at Bradley Lake on the Kenai Peninsula at the head of Kachemak Bay. The facility proposed would generate 0.4 billion kilowatt-hours of firm annual energy and could serve as



DEVIL CANYON

WATANA





VEE

DENALI

a southern peaking installation for a Southcentral Railbelt power system. There would be a minimum of adverse environmental impacts associated with this proposed project.

This alternative provides only a small portion of the projected energy needs. Although development at a later date to supplement other energy sources might be warranted, further study of this alternative is not deemed justified for this report.

Susitna River: Surveys for potential hydropower development in the Susitna River basin were reported by the Corps of Engineers in 1950 and by the U.S. Bureau of Reclamation in 1948, 1952, 1961, and 1974. The 1952 USBR report indicated 12 potential hydropower sites in the basin; of these, the 5 damsites studied in the upper Susitna basin showed the highest potential. These studies showed the environmental impact from projects in the Upper Susitna River Basin would not be as severe as those from other basins, and the firm energy potential could contribute substantially to satisfying the needs of the Southcentral Railbelt area. Eight hydroelectric plans for hydroelectric development of the Susitna River basin were studied for this report. These include three single dams, two two-dam systems, a three-day system, and two four-dam systems, as follows:

Single Dams:

Devil Canyon: The possibility of a single dam development of the upper Susitna basin located at the Devil Canyon damsite was investigated. The proposed thin-arch dam would have a water surface area of about 7,550 acres at the normal maximum pool elevation of 1,450 feet, m.s.l. The project would produce 0.9 billion kilowatt-hours of firm annual energy from dependable capacity of 205 megawatts. Because of the very limited storage capacity, the project, by itself, has a low firm energy capability and is not economically viable. Further study of this alternative is not deemed justified for this report.

Devil Canyon High (Susitna I): In September 1974, Henry J. Kaiser Company prepared a reassessment report proposing an alternative hydroelectric development project on the upper Susitna River. The report states that an initial project proposing an 810-foot high, concrete faced, rockfill dam located about five miles upstream from the proposed Devil Canyon site would provide 3.2 billion kilowatts of average annual energy. For comparison with the other proposals, this converts to about 2.6 billion kilowatt-hours of firm annual energy. The project is not economically feasible. Further study of this alternative is not deemed justified for this report.

Watana: The proposed single dam development of the upper Susitna basin located at the Watana site would be an earthfill dam with structural height of about 810 feet. The reservoir would have a normal maximum pool elevation of 2,200 feet, would have a surface area of approximately 43,000 acres, and would extend about 54 river miles upstream to a point between the Oshetna and Tyone Rivers. The annual firm electrical production of Watana would be 3.1 billion kilowatt-hours from a dependable capacity of 706 megawatts. Such a project would be economically feasible; however, it would develop only about one-half of the basin potential while having adverse environmental effects of nearly the same magnitude as plans having both economic feasibility and twice as much power output. Further study of this alternative is not deemed justified for this report.

Two-Dam Systems:

Devil Canyon-Denali: This alternative system would include the thin-arch concrete dam at Devil Canyon and a 260-foot-high earthfill dam in the vicinity of Denali. The Denali Dam would provide storage only and would have no powerhouse. This system would generate 2.5 billion kilowatt-hours of firm annual energy from a dependable capacity of 571 megawatts at Devil Canyon Dam. The surface acres flooded would total about 62,000 acres (Devil Canyon, 7,550; Denali, 54,000). Project energy output is less than half of the basin potential and economic feasibility is lacking. Further study of this alternative is not deemed justified for this report.

Devil Canyon-Watana: This alternative two-dam system would include the concrete dam at Devil Canyon plus the earthfill dam at Watana. The firm annual production of electrical power with these two dams would be 6.1 billion kilowatt-hours from a dependable capacity of 1,568 megawatts. The reservoirs would flood approximately 51,000 acres (Devil Canyon, 7,550; Watana, 43,000), and extend to a point between the Oshetna and Tyone Rivers. This project is economically feasible and develops nearly 96 percent of the basin potential. Further study and evaluation of this alternative is justified.

Three-Dam System:

Devil Canyon-Watana-Denali: This system would add the 54,000-acre Denali storage reservoir to the previous plan. The combined electrical production of the three dams would provide 6.8 billion kilowatt-hours of firm energy annually from a dependable capacity of 1,578 megawatts. The surface area flooded would be approximately 105,000 acres (Devil Canyon, 7,550; Watana, 43,000; Denali, 54,000). This alternative would develop nearly the full basin potential. Even though probable environmental effects would be considerably greater than the preceding two-dam system, further study and evaluation of this alternative is justified.

Four-Dam Systems:

Devil Canyon-Watana-Vee-Denali: This is the system proposed by the Bureau of Reclamation in its 1952 report on hydropower resources of the Upper Susitna River Basin. USBR recommended initial development of Devil Canyon Dam plus the upstream storage reservoir at Denali; further development would include earthfill dams at the Watana and Vee Canyon sites between the two initial dams. In this system, the height of the Watana Dam would drop from 810 feet to 515 feet. The height of the Vee Dam would be 455 feet. This system would generate 6.1 billion kilowatt-hours of firm annual electrical energy from a dependable capacity of 1,570 megawatts. The surface area flooded by these four dams would total approximately 85,000 acres (Devil Canyon, 7,550; Watana, 14,000; Vee, 9,400; Denali, 54,000). This alternative would also develop about 95 percent of the full basin potential. Even though probable environmental effects would be as great or greater than the preceding three-dam system, further study and evaluation of this alternative is justified.

High Devil Canyon (Susitna I)-Olson (Susitna II)-Vee (Susitna III)-Denali: The September 1974, Henry J. Kaiser Company's report also proposed a four-dam ultimate development plan for the Upper Susitna River Basin. The Kaiser plan was not detailed except as to the Devil Canyon High Dam (Susitna I), but in effect proposed a low dam (Susitna II) at a site which is equivalent to the Olson damsite of USBR, a higher dam (Susitna III) at the upstream limit of the Susitna I reservoir, and a storage dam at Denali. For comparison purposes, the Susitna II and Susitna III dam concepts have been equated to USBR's Olson Dam and Vee Dam. On this basis, the firm annual energy would be 5.9 billion kilowatt-hours and the surface acres flooded would total about 88,000 acres (High Devil Canyon, 24,000; Olson, 850; Vee, 9,400; and Denali, 54,000). The system not only develops less of the basin potential than several other alternatives but is not economically justified. Further study of this alternative is not deemed justified for this report.

ALTERNATIVES SELECTED FOR FURTHER STUDY

The preliminary screening disclosed four alternatives with economic justification, adequate scale, technical feasibility, and no adverse environmental effects of such obvious magnitude as to preclude plan implementation. These include one plan which depicts the most probable future if no Federal action is taken to meet the projected power needs of the Railbelt and three diverse hydroelectric plans for utilization of the power potential of the upper Susitna River. The four selected alternatives are:

Coal
Devil Canyon-Watana Dams
Devil Canyon-Watana-Denali Dams
Devil Canyon-Watana-Vee-Denali Dams.

EVALUATION OF ALTERNATIVES

Selection of the best plan from among the alternatives involves evaluation of their comparative performance in meeting the study objectives as measured against a set of evaluation criteria.

These criteria derive from law, regulations, and policies governing water resource planning and development. The following criteria were adopted for evaluating the alternatives.

Technical Criteria:

The growth in electrical power demand will be as projected by the Alaska Power Administration.

That power generation development, from any source or sources, will proceed to satisfy the projected needs.

A plan to be considered for initial development must be technically feasible.

National Economic Development Criteria:

Tangible benefits must exceed project economic costs.

Each separable unit of work or purpose must provide benefits at least equal to its cost.

The scope of the work is such as to provide the maximum net benefits.

The benefits and costs are expressed in comparable quantitative economic terms to the fullest extent possible. Annual costs are based on a 100-year amortization period, an interest rate of 6-1/8 percent, and January 1975 price levels. The annual charges include interest; amortization; and operation, maintenance, and replacement costs.

Power benefits are based on the costs of providing the energy output of any plan by conventional coal-fired thermal generation.

Environmental Quality Criteria:

Conservation of esthetics, natural values, and other desirable environmental effects or features.

The use of a systematic approach to insure integration of the natural and social sciences and environmental design arts in planning and utilization.

The application of overall system assessment of operational effects as well as consideration of the local project area.

The study and development of recommended alternative courses of action to any proposal which involved conflicts concerning uses of available resources.

Evaluation of the environmental impacts of any proposed action, including effects which cannot be avoided, alternatives to proposed actions, the relationship of local short-term uses and of long-term productivity, and a determination of any irreversible and irretrievable resource commitment.

Avoidance of detrimental environmental effects, but where these are unavoidable, the inclusion of practicable mitigating features.

Social Well-Being and Regional Development Considerations:

In addition to the basic planning criteria, consideration was given to:

The possibility of enhancing or creating recreational values for the public;

The effects, both locally and regionally, on such items as income, employment, population, and business;

The effects on educational and cultural opportunities;

The conservation of nonrenewable resources.

Coal: This alternative is, effectively, the "without" condition, the probable future that would develop if no Federal action were taken to provide electrical power through a hydroelectric generation development. It is the economic standard against which each of the hydropower plans is tested. That is, the power benefits of a given hydro system represent the cost of producing the same amount of power by constructing and operating a conventional, state-of-the-art, generation system using coal as fuel. Included in all cases are the costs of the necessary transmission systems to bring the power to the same load distribution centers in the Anchorage and Fairbanks areas. Thus, a benefit-to-cost ratio of greater than one (1.0) indicates that a hydro system is more economical than its coal competitor, while a ratio of less than unity indicates that it is economically inferior. For any given alternative coal system, the sum of the energy and capacity benefits is identical to the costs giving a benefit-to-cost (B/C) ratio of 1.0 and no net benefits.

The coal-fired development most directly comparable to the hydropower alternatives would be a single large complex located near Healy, with a transmission system essentially identical to the Anchorage-Fairbanks intertie provided by the hydro plants. However, such a massive capital investment by private interests is less likely than continued separate expansion of the existing local generation-distribution systems. For this reason, the coal alternative considered hereafter will consist of two mine-mouth plants, one at Beluga serving the Anchorage-Kenai Peninsula load center, and one at Healy serving the Fairbanks load center. No transmission intertie would be provided.

The two powerplants would have the following projected characteristics:

Load Center	Fairbanks	Anchorage-Kenai	Total
Plant Location	Healy vicinity	Beluga vicinity	
Size and No. of Units			
Initial (c. 1980)	2-75 mw	3-150 mw	
Final (c. 1995)	4-75 mw	8-150 mw	
Total Capacity-Final	300 mw	1,200 mw	1,500 mw
Land Required (Acres)			
Buildings and Grounds	10	30	40
30-day Stockpile	20	70	90
Stripmining (Acres)			
Per Year	44	140	184
100-year Total	4,400	14,000	18,400
Coal Consumption (million T)			
Per Year	1.44	4.41	5.85
100-year Total	155	441	585
Waste Disposal (Acres)			
Per Year	4.4	14	18.4
100-year Total	440	1,400	1,840
Mill Rate to Distributor	31.4	26.4	

The Healy Creek district has estimated reserves of 537.5 million tons of coal in seams over five feet thick and under less than 1,000 feet of overburden. The Beluga River and adjacent Capps Glacier districts have estimated reserves of 242.7 million tons and 405.8 million tons, respectively, of coal in similar formations.1/ Thus, among the three districts, there appears to be sufficient stripable coal to sustain both plants for required century.

To estimate the probable impacts from strip mining, an idealized mining operation was projected, which resulted in each acre of mine producing 209,733 cubic yards of material composed of 29,040 cubic yards of recovered coal and 180,693 cubic yards of mine wastes. The annual coal requirement would mean that a total of 183 to 184 acres of land annually would have to be mined, or 18,300 to 18,400 acres in 100 years. It should be emphasized that the disturbed acreage is based on a relatively favorable formation of coal seams and on a 90-percent rate of recovery which both tend to minimize the land requirements.

The Healy Creek Valley is covered by upland spruce-hardwood forest below 2,500 feet, m.s.l. The higher lands are generally alpine tundra. As a result, the majority of the area is classified as fall and winter moose concentration area. Dall sheep range extends on both sides of the valley and along the southern rim of the westward area. The valley upstream of the 2,500-foot elevation is winter range for caribou. The valley of the Nenana River running north-south at the western end of Healy Creek is listed as a nesting-moulting area for waterfowl and a major migration route (flyway). The Nenana River supports both resident and anadromous fish.

Vegetation at the Beluga River-Capps Glacier area occurs as three bands parallel to Cook Inlet. Adjacent to the water is a 3-5-mile-wide band of wet tundra. Next, there is a 10-12-mile-wide band of upland spruce-hardwood forest. Finally, there is a wide area of lowland spruce-hardwood with spots of muskeg, bog, and high brush. Waterfowl, especially during spring and fall migrations, make heavy use of the area, with the result that it is classified as extremely important for resting. Ducks predominate although small numbers of geese and swans also pass through. Moose occur throughout the entire region with significant fall concentrations to the north of Beluga River and spring and winter concentrations in the tundra band astride the mouth of the river. Black and brown-grizzly bear range the entire region with suspected brown bear denning areas between Capps Glacier and Beluga Lake. Beluga River and other streams are salmon spawning areas, while Beluga Lake supports resident populations of several species.2/

1/ Coal Resources of Alaska, Geological Survey Bulletin 1242-B, 1967.
2/ Alaska's Wildlife and Habitat, Alaska Department of Fish and Game, 1973.

Thus, at either locale, the destruction of the vegetative cover and land disturbance would be, acre for acre, destruction of important wildlife habitat. Natural revegetation would be possible, but very slow. Artificial revegetation could restore habitat much more quickly, but at an increased price of power. In addition to the effects on wildlife habitat, the coal alternative would have a range of other environmental impacts. The mining and hauling of the coal could be expected to put considerable amounts of dust into the air around the projects. Since the operations would, in general, be following natural water courses, there is a strong probability that sediments could not be prevented from reaching the streams and being carried into the major rivers where the increases in turbidity could be expected to have adverse effects on fish populations. Further, although the coal is low in sulfur content, ground water and runoff waters in contact with the beds and the uncovered coal residues could well experience chemical changes which in turn could have adverse effects on the rivers, their fish, and other aquatic biota.

The operation of the generating plants would have environmental impacts also. Even with pollution control devices to restrict and/or remove harmful substances, there would be some degradation of air quality from water vapor, carbon particles, sulfur compounds, and unburned gases to the limits permitted by air quality regulations. The characteristic odor of burning coal would be pervasive over wide areas, including Tyonek and perhaps Anchorage. Water, either from groundwater sources, or more likely, from the major rivers would be required to provide cooling for the steam condensers of the plants. This water would need to be returned to the rivers in exchange for cold waters to continue the function of system. This could effect a sharp change in the thermal regime of the rivers with possible adverse effects on their ecosystems. Alternatively, cooling towers or other artificial means could be installed to avoid thermal pollution, but at a substantial increase in the costs of the project. Other possible environmental impacts from the plant lie in the need for disposal of the solid combustion wastes. These could be added to the mine wastes, thus increasing the bulk of these spoil ridges or could be disposed on other lands. Either method would involve probable adverse effects in that the ash-cinders would tend to hinder efforts at revegetation of the mine wastes while dumping elsewhere would remove additional acreage from wildlife habitat or other beneficial use. Again, leaching of chemicals by surface waters could well cause water quality problems in the streams of the disposal area.

The Healy Creek vicinity has a long history of mining and mineral exploration which increases the probability that historic sites would be of above average occurrence within the area of project effects. The State Division of Parks considers the area to be extremely rich in archaeological potential. The west shore of Cook Inlet and the Beluga Lake area also have a long history of habitation or use by indigenous peoples of the region. As such, it also should be rich in potential for the discovery of historic and/or prehistoric sites. Strip mining would tend to have adverse effects on preservation of historic sites while it could both encourage discovery and recovery of prehistoric artifacts and destroy sites for continued archaeological study.

The coal alternative would make no contribution to either flood control or recreation in the Railbelt area. In fact, the destruction of habitat and the widespread presence of human activities could be expected to reduce the recreational potential for hunting and fishing.

It is estimated that construction of the coal facilities would impact on the regional economy in much the same way and magnitude as the alternative hydropower plans. The year-by-year effects would be more evenly spread over a longer total period since construction would be in several stages as the power demand grew and would not be completed (to the output level of the hydropower alternatives) until about 1995. Permanent jobs arising from operation of the facilities are estimated to be 67 in the mining-hauling of the coal, and 35 in actual powerplant operation and maintenance.

Response to Study Objectives: The response of the coal alternative to the study objectives is summarized as follows:

Power: Provides power equivalent to any other alternative (6.88 to 6.91 billion kilowatt-hours annually). Meets the projected demand until the mid-1990's.

Flood Control: Nonresponsive.

Air Pollution: Adverse response.

Fish and Wildlife: Direct loss of 18,000-20,000 acres of important moose, caribou habitat, bear, and waterfowl. Probable adverse effects on anadromous fish. No positive contributions.

Recreation: Nonresponsive.

Conservation of Nonrenewable Resources: Adverse response--expend 5.83-5.85 million tons of coal annually.

Energy Independence: Conserves equivalent of 112.5-112.9 billion cubic feet of natural gas annually, or 15.1-15.2 million barrels of oil.

Devil Canyon-Watana: This alternative would consist of a concrete thin-arch dam 635 feet high with a four-unit powerhouse and a switchyard at river mile 134 of the Susitna River, an earthfill dam 810 feet high with a three-unit powerhouse and a switchyard at river mile 165, an access road 64 miles long from the vicinity of Chulitna Station on the Alaska

Railroad and the Parks Highway, and 364 miles of transmission lines. Included in the permanent facilities would be living quarters for operating personnel, visitor centers at each dam, boat launching ramps, and a limited system of recreational facilities including camping spots and hiking trails. The first cost of the project is estimated as $1.52 billion. Annual costs are estimated as $104,020,000, including $2,500,000 for operation, maintenance, and replacements. Average annual project benefits accrue as follows:

Power	$128,153,000
Recreation	300,000
Flood Control	50,000
Area Redevelopment	9,373,000
Total	$137,876,000

The benefit-to-cost (B/C) ratio is 1.3 to 1.
Net annual benefits are $33,856,000.

The system would have an average annual energy output of 6.91 billion kilowatt-hours and a firm energy output of 6.10 billion kilowatt-hours from an installed capacity of 1,394 MW. The projected energy cost to the distributors would be 21.1 mills per kilowatt-hour.

Known and suspected project impacts for the proposed Devil Canyon-Watana hydroelectric project are discussed below.

River Flows: The natural average daily flows at Devil Canyon from the latter part of May through the latter part of August fluctuate in the range of 13,000 to 27,000 cubic feet per second (cfs). For November through April, the average daily flows range between 1,000 and 2,300 cfs. The river also carries a heavier load of glacial sediment during high runoff periods. During winter when low temperatures reduce water flows, the streams run practically silt free.

With a project, significant reductions of the late spring and early summer flows would occur and substantial increases of the winter flows. The average regulated downstream flows for this plan computed on a monthly basis are estimated between about 7,600 cfs in October to about 15,000 cfs in August. In extreme years, the monthly averages would range from about 6,500 cfs to over 28,000 cfs. The following table compares natural and regulated flows.

Month	Regulated cfs	Unregulated cfs
January	9,896	1,354
February	9,424	1,137
March	9,020	1,031
April	8,261	1,254
May	8,192	12,627
June	8,324	26,763
July	9,618	23,047
August	15,066	21,189
September	10,802	13,015
October	7,556	5,347
November	8,367	2,331
December	8,964	1,656

The high flows of the summer and fall plus unregulated flood flows of much higher magnitude presently require an average annual expenditure of $50,000 by the Alaska Railroad to prevent erosion of the roadbed. The regulated flows would make such protection unnecessary. The resulting savings is the source of the flood control benefit.

Water Quality: The heavier sediment material now carried by the river between Devil Canyon and the junction of the Chulitna and Talkeetna Rivers with the Susitna River during high runoff periods would be substantially reduced, and a year-round, somewhat milky-textured "glacial flour" (suspended glacial sediment) would be introduced into the controlled water releases below the dams. Preliminary studies indicate that the suspended materials in the releases below the dams would be in the range of 15 to 35 parts per million.

On occasions after the development of upstream storage, when spilling over Devil Canyon Dam would be necessary during periods of high flows, nitrogen supersaturation could be introduced into the river below the dam and would cause an adverse impact on fish for some distance downstream from the dam depending on the level and duration of the supersaturated condition. Fish exposed to this environment suffer gas bubble disease (like bends to a deep-sea diver) which is often fatal, particularly to juvenile salmon.

With the use of appropriate operational procedures, spilling would occur about every second year with an average annual duration of 14 days. Nitrogen supersaturation introduced by the spilling should be substantially reduced in the turbulent river section just downstream of the dam. The proposed spillway at the Watana Dam is not conducive to nitrogen supersaturation. Because of the flood storage capacity of this fluctuating impoundment and the large release capabilities of the outlet works and powerhouse, use of the spillway should be required only about once in 50 years.

Compared to natural conditions, temperature of the controlled releases of water from Devil Canyon Dam would tend to be cooler in the summer and warmer in the winter. Cooler summer water temperatures and warmer winter water temperatures could have both beneficial and adverse effects on migrating salmon, juvenile salmon, and resident fish populations, and will be investigated further in post-authorization studies.

Variations in water releases at Devil Canyon Dam would cause less than a one-foot daily fluctuation of downstream water levels in the river during the May through October period unless the reservoir were to be used for peaking purposes. The regulated daily fluctuations during the winter months could range up to two feet under normal peaking conditions. According to U.S. Geological Survey studies, the natural normal daily fluctuations in the Susitna River below Devil Canyon range up to about one foot.

Stratification conditions within the reservoirs could cause some temperature and dissolved oxygen problems in the river for some distance downstream from the Devil Canyon Dam and within the reservoirs themselves. This could have an adverse impact on the downstream fishery and to fish within the reservoirs.

The multilevel intake structures at both dams provide for selective withdrawal of waters from varying depths within the reservoirs. This feature allows for considerable control of both downstream water temperature and dissolved oxygen content of the release waters. Because the lowest intake levels are well above the dead storage areas of the reservoirs, there should be no increase in passage of sediments even when the deepest intake levels are used.

General channel degradation caused by a river's attempt to replace the missing sediment load with material picked up from the riverbed is not expected to be a significant concern along the gravel bed reaches of the Susitna River between Talkeetna and Devil Canyon. There will undoubtedly be some degradation where bed conditions are favorable. It is expected that the river will channelize into a single deep watercourse during the winter months. However, because of the generally coarse nature of the surface materials of the riverbanks, no significant bank erosion is predicted.

Upstream from the dams the major environmental impacts would be caused by the reservoir impoundments. The reservoir behind the Devil Canyon Dam would remain essentially full throughout the year, while Watana reservoir would fluctuate between 95 and 120 feet below full pool during the average year.

Devil Canyon reservoir would cover about 7,550 acres in a steep walled canyon with few known areas of big-game habitat and a minimal amount of resident fish habitat at the mouths of some of the tributaries that enter the Susitna River in the 28-mile section above the proposed damsite. The reservoir would, however, flood 9 of the 11 miles of the whitewater section known as Devil Canyon. These rapids are highly regarded by whitewater enthusiasts for their extreme violence and for their rarity, being rated as Class VI--cannot be attempted without risk of life to the most expert boatman. This very violence has, to date, limited recreational boating use of this section of the river to only a few highly expert individuals and/or parties. No significant future use by the general public, either for active boating or esthetic appreciation, seems likely considering the difficulty of access and the extreme danger of the waters. Construction of this alternative project would provide access to the canyon area and the remaining two miles of rapids below Devil Canyon Dam.

Watana reservoir would flood about 43,000 acres in a 54-mile section of the Susitna River that would reach upstream to the Oshetna River. Except in a few areas near the mouths of tributary creeks and most of the Watana Creek valley, the Watana reservoir would be contained within a fairly narrow canyon for much of its length.

Watana reservoir would flood areas used by migrating caribou in crossing the Susitna River and would also flood moose winter range in the river bottom. The reservoir would cover existing resident fish habitat at the mouths of some of the tributaries and possibly would create other fish habitat at higher elevations on these tributaries.

Fish: How some of the downstream river conditions caused by the proposed hydropower project would affect the anadromous and resident fish populations below the dams has not yet been fully determined, but past, ongoing, and future studies by State and Federal agencies coordinated by the U.S. Fish and Wildlife Service should provide the answers needed to further define adverse and beneficial impacts of the proposed project on fish and wildlife.

In a 1974 study by the Alaska Department of Fish and Game on surveys conducted to locate potential salmon rearing and spawning sloughs on the 50-mile section of the Susitna River between Portage Creek and the Chulitna River, 21 sloughs were found during the 23 July through 11 September study period. Salmon fry were observed in at least 15 of these 21 backwater areas. Adult salmon were present in 9 of the 21 sloughs. In 5 of the sloughs, the adult salmon were found in low numbers (6 to 7 average). In 4 other sloughs, large numbers were present (350 average).

During December 1974 and January and February 1975, the Alaska Department of Fish and Game investigated 16 of the 21 sloughs previously surveyed during the summer of 1974. Of the 16 sloughs, 5 indicated presence of coho salmon fry. Many of the 16 sloughs surveyed were appreciably dewatered from the summer/fall state. Also, a number of coho fry were captured in the Susitna River near Gold Creek, indicating that some coho salmon fry do overwinter in the main river.

It is reasonable to assume on the basis of existing data that there will be some changes in the relationship between the regulated river and access to existing salmon rearing and spawning sloughs and tributaries downstream from Devil Canyon Dam. It appears feasible to develop a program to improve fish access to and from some of the sloughs and tributaries in the Susitna River, if such is determined to be needed as a consequence of the project's stabilizing effect on summer flows. Such a program would be a project consideration.

Periodic flood conditions that presently destroy salmon eggs in this stretch of the river would be almost completely eliminated by regulation of the upper Susitna River flows.

Reduction in flows, turbidity, and water temperatures below Devil Canyon Dam might cause some disorientation of salmon migrating into the section of the Susitna River between Portage Creek and the Chulitna River during an initial period after construction of the dams.

According to a study discussed in the Journal of Fisheries Research Board of Canada--Volume 32, No. 1, January 1975, Ecological Consequences of the Proposed Moran Dam on the Fraser River, some of the beneficial downstream impacts of the dam could include the following:

The higher regulated winter flows might enhance the survival of salmon eggs in the river downstream from the dam. The increased flows could insure better coverage and better percolation through the gravel and presumably enhance egg and alevin survival.

An additional consequence of reduced turbidity below the dam might be a gradual reduction in the percentage of fine materials in the salmon spawning areas. This could also lead to improved percolation through the gravel in the streambed and possibly improve survival of eggs.

Reduced siltation during the summer months could prove beneficial for both anadromous and resident fish species in the 50-mile section of the Susitna River between the proposed Devil Canyon Dam and Talkeetna. With the almost total elimination of the heavier glacial sediment loads of the river, it is likely that the potential for recreational sport fishing would be improved in this section of the Susitna.

Upstream from the dams, the major impact on the resident fish populations would be caused by the reservoir impoundments. Devil Canyon reservoir would fluctuate very little. The steep-walled canyon of this reservoir might prove less than desirable to develop a resident fish population; however, some species of fish might adapt to this reservoir and provide sport fishing benefits.

Watana Dam would have a widely fluctuating reservoir and thus be generally detrimental to the development of resident fish populations. Suspended glacial sediment could be a factor in both of the reservoirs after the heavier glacial sediments have settled out; however, many natural lakes in Alaska such as Tustumena and Tazlina, with silt-laden inflows sustain fish populations under similar conditions.

Most resident fish populations, especially grayling, utilize the clearwater tributaries of the Susitna River or areas near the mouths of these streams as they enter the glacially turbid main river during periods of high runoff. All of these tributaries, approximately 10 in number, would be flooded in their lower reaches by the proposed reservoir impoundments. Resident fish populations would be affected by the increased water levels in the proposed reservoirs. In about half of the areas, access to the less precipitous slopes of the upper tributaries would be improved by increased water elevations and could benefit resident fish populations.

Fish would experience extremely high mortality rates if they attempted to migrate downstream through turbines or outlet works at the proposed dams.

It appears highly unlikely that anadromous fish such as salmon could be introduced into the Upper Susitna River Basin. The related problems and costs of passing migrating fish over and through high dams appear infeasible. However, the introduction of a resident land-locked salmon species, such as sockeye (kokanee), to some waters of the upper Susitna basin might prove feasible.

<u>Wildlife</u>: Reservoir impoundments behind the proposed dams would have varying degrees of environmental impact on wildlife.

The Devil Canyon reservoir would be located within the confines of a narrow, steep-walled canyon with few areas of big-game habitat and no major migration routes for big-game animals. Based on observations of terrain slopes, and vegetation, it is estimated that about 100 acres of this reservoir might be favorable moose habitat. The reservoir would create about 65 miles of lake shoreline. Because the pool level would vary little, it is assumed that a fringe of water-oriented vegetation such as willow or alder would develop along the shore. Such a fringe zone could provide favorable habitat for a variety of small mammals and birds, and might provide replacement habitat for moose. A continuous fringing zone only 50 feet in width around the lake would represent 300-400 acres.

The proposed Watana Dam would be generally contained within a fairly deep and narrow river canyon. Watana reservoir would lie across one of the intermittent caribou migration routes between the north side of the Susitna River and the main calving area of the Nelchina caribou herd, located south of the river in the northeast foothills of the Talkeetna Mountains. Calving generally takes place during a month-long period starting in the middle of May. Ice-shelving conditions along the shoreline caused by winter drawdown on Watana reservoir or ice breakup conditions on the reservoir could cause problems for caribou migrating to the calving grounds. This reservoir would have a high water shoreline about 145 miles long. Development of a fringe habitat would be considerably less likely than for Devil Canyon because of the highly variable water level of the lake. Creation of beneficial habitat is doubtful.

As caribou are strong swimmers, they should have fewer problems crossing the narrow reservoir during July after calving than they would crossing the swollen glacial river during natural periods of high runoff. Caribou could migrate around the reservoir. Caribou migration patterns for the Nelchina herd are continually changing, as stated in Alaska Department of Fish and Game study reports. Under adverse ice conditions, the reservoirs could cause increased mortality in some segments of the herd, and some permanent changes in traditional herd movements.

A moose survey conducted in early June 1974 by the Alaska Department of Fish and Game indicated that, although spring counting conditions were less than ideal, a total of 356 moose were seen along the upper Susitna River and in the lower drainage areas of the major tributaries. A 1973 fall count in the same general area sighted a total of 1,796 moose. Of the 356 moose counted in the June 1974 survey, 13 were seen in the area of the proposed Watana reservoir. None were sighted within the proposed Devil Canyon reservoir impoundment. Based on visual observations and map studies of vegetation and terrain slopes, it is estimated that 2,000 to 3,000 acres, mostly in the lower reaches of Watana Creek, could be favorable moose habitat. Wildlife management agencies state that such habitat for moose should be considered as critical, especially as winter habitat. Further studies to delineate both the extent and value of the habitat would be required to determine the need and/or extent of mitigation.

The loss of habitat for bears, wolves, wolverines, Dall sheep, and other animals appears to be minimal. Other birds, including raptors, songbirds, shorebirds, and game birds, do not appear to be significantly affected by the reduction of habitat in the area of the proposed dams and reservoirs, although some habitat will be lost for all species of wildlife.

Road access to the two damsites could have a significant impact on fish and wildlife resources in areas opened to vehicle encroachment. Specific areas such as Stephan Lake, Fog Lakes, lower Deadman Creek, and the northern slopes of the Talkeetna Mountains could be greatly impacted by hunters, fishermen, and other recreationists as a result of the access road to Watana Dam. However, such an impact is properly a function of the establishment and enforcement of proper regulations by management authorities, not of the project.

The proposed reservoirs at Devil Canyon and Watana are located along a major flyway for waterfowl. Very few waterfowl appear to nest on the sections of the river that would be flooded by these reservoir proposals. On the other hand, the reservoirs would provide suitable resting areas for waterfowl migrating through the basin.

Migrating birds would possibly suffer some mortality from collisions with towers or lines, but such losses should be negligible. The line would generally parallel normal north-south migration routes. The cables would be large enough to have a high degree of visibility and would be widely enough spaced to be ineffective snares. Electrocution of birds is also unlikely since the distance between lines and between lines and ground would be great enough to make shorting out by birds almost impossible.

A transmission line per se will not have many impacts upon wildlife; most of the impacts will be as a result of construction and maintenance. Direct destruction will affect the less mobile animals such as the small mammals, whose territories may be small enough to be encompassed by the construction area. The significance of this impact to these animals is small in relation to their population in surrounding areas.

<u>Recreation</u>: Much of the Upper Susitna River Basin, except near the Denali Highway and Lake Louise vicinity, has little recreational activity at the present time. A combination of poor road access, rough terrain, and great distances limits the use of the 5,800-square-mile basin, especially the lands directly impacted by this alternative, to a few hunters, fishermen, and campers who utilize these lands for recreational purposes.

The construction of the proposed hydroelectric project would have an impact on a number of present and projected recreational activities both in the immediate dam and reservoir areas and downstream from the dams.

At the present time, the Susitna River upstream from Portage Creek to the Denali Highway bridge is a free-flowing river with few signs of man's activities. The construction of dams on the river would change sections of the river into a series of manmade lakes. The violent, whitewater section of the river through the area known as Devil Canyon would be substantially inundated by a dam at the Devil Canyon site. Other areas of the river would also be changed from river-oriented recreational opportunities to lake-oriented recreational activities.

Improved road access into some areas of the upper Susitna basin would substantially increase pressures on all the resources impacted by outdoor recreational activities within these areas.

The construction of project-oriented recreational facilities would substantially increase the recreational use of the areas around the proposed dams and reservoirs. These recreational facilities could include visitor facilities at the dams, boat launching facilities on the reservoirs, campgrounds, picnic areas, trail systems, and other related recreational facilities. Recreational facilities at Devil Canyon and Watana could also be developed to complement the 282,000-acre Denali State Park complex, which is located on the Parks Highway just west of the settlement of Gold Creek.

Few people reside within a 100-mile radius of the project area at the present time and day-use of the project by local residents would be minimal.

A project related recreational development program would involve cooperation between the Bureau of Land Management and the operating agency for maintenance of the developed recreational facilities. The projected recreational program would provide for an estimated 77,000 use days of recreation, mostly fishing, camping, hiking, and sightseeing. This is the source of the recreational benefit.

Historic and Archaeological Sites: The current National Register of Historic Places has been consulted, and no National Register properties will be affected by the project. A recently completed study for the Corps of Engineers, made by the Alaska Division of Parks, indicated 11 historic sites within the study portion of the upper Susitna basin, all of which are related to the discovery of gold. One known site (cabin) is in the proposed reservoir impoundment areas.

Only one archaeological site has been examined within the study area of the upper Susitna basin, and it has never been excavated. This is the Ratekin site, several miles east of the Susitna River near the Denali Highway. The Division of Parks survey projects a total of 40 zones of possible archaeological interest within the Devil Canyon and Watana impoundments.

Mining: The Susitna River basin in the proposed reservoir impoundment areas is generally favorable for various types of mineral deposits, but the area has never been mapped geologically. An extensive mineral examination program is expected to be necessary in the areas of proposed hydroelectric development, and this program would probably be funded to assess mineral resource potential.

Transmission System: Most of the power generated by hydroelectric development on the upper Susitna River would be utilized in the Fairbanks-Tanana Valley and Anchorage-Cook Inlet areas. For this study, a transmission system, consisting of two 230-kv single circuits from the project area to Fairbanks, and two single circuit 345-kv lines to the Anchorage area, is planned. All lines would generally parallel the Alaska Railroad, and would be connected to generation facilities at both Devil Canyon and Watana.

Most direct impacts of the transmission line upon vegetation would be relatively small with respect to the magnitude of surrounding unaffected land. Up to 6,100 of the approximately 8,200 acres of right-of-way would have to be cleared. The cleared right-of-way would have a major impact on scenic quality. Regrowth beyond a limited height would have to be prevented by maintenance so that cuts through forested areas would be permanently visible. In more open areas at higher elevations, such as Broad Pass, this effect would be as significant. However, in such areas the line itself would be visible.

Disposal of slash and debris has potentially adverse effects on remaining vegetation and other resources. Regardless of the method of disposal chosen, some impacts could be expected.

Roads: Permanent roads would be built to provide access from the Parks Highway to the Devil Canyon and Watana damsites. Permanent roads would also provide access to proposed recreational facilities within the project area. Temporary roads for project construction and reservoir clearing operations would also be constructed.

Resource values impacted by proposed roads include fish, wildlife, vegetation, recreation, scenery, water, and soils. Air and noise pollution related to road construction and dust generated by vehicle travel on unpaved roads could also be significant though temporary adverse environmental impacts.

Design, location, construction, rehabilitation, and maintenance of a project road system should give prime consideration to the utilization of good landscape management practices.

Construction Activities: Project related construction activities would include the building of the dams and related facilities; the clearing of reservoir areas; the construction of roads, electrical distribution systems, and recreational facilities; and the building of facilities for workers. The construction of the Devil Canyon and Watana project is estimated to take 10 years to complete, with an estimated 5 to 6 years required for construction at each of the two sites. The activities will overlap as simultaneous construction will occur in the final 1-2 years of the Watana project.

The activities themselves would cause varying degrees of physical pollution to the air, land, and water within the project area and to some areas outside the development area. Fish, wildlife, vegetation, visual resources, soils, and other resource values could be severely impacted by construction activities.

Roads and other facilities would be needed in order to obtain materials from borrow sources and quarry sites for the construction of the dams. Areas would also be needed to dispose of some materials and debris. All construction activities could be controlled to minimize or to eliminate adverse environmental impacts; environmental enhancement could be considered where feasible.

Workers' Facilities: No communities within commuting distance of the proposed project area could absorb the number of workers required for the construction of the dams and related facilities. Temporary construction camps with the necessary facilities would need to be provided during the construction periods. Permanent facilities would have be built for maintenance and operational personnel after completion of the construction phase.

The construction and operations of the workers' camps would have to meet State and Federal pollution control laws and standards, and all activities could be controlled to minimize the adverse environmental impacts presented by the camps.

Esthetics: The project would be located in areas that have practically no permanent signs of man's presence. The land between Portage Creek and the Denali Highway is an undisturbed scenic area.

The construction of a hydroelectric project would have a substantial impact on the existing natural scenic resource values within the project area. Any dam construction on the upper Susitna would change a free-flowing river into a series of manmade lakes. Devil Canyon reservoir would fluctuate up to 5 feet, while Watana reservoir could fluctuate up to 120 feet below full pool under normal operating conditions. The seasonal fluctuation of the Watana impoundment would not have a substantial scenic impact, inasmuch as the major drawdown would occur in the winter when public access was not possible, and the pool would be essentially refilled by the time access was restored. The whitewater section of the Susitna River through Devil Canyon would be substantially inundated by a dam at Devil Canyon. Roads and transmission lines would also impact the natural scenic resource values of the area.

After dam construction, many visitors could view the manmade structures and their reservoirs. It can be expected that a considerable number of tourists and State residents would visit the dams.

If consideration were given to minimizing the adverse impacts of construction activities, a great deal could be accomplished to maximize scenic resource values within the project area. Good landscape management practices would add substantially to the recreational experience of the project visitor.

Air Pollution: Most of the existing electrical power in the Southcentral Railbelt area is produced by gas, coal, and oil-fired generating units which cause varying degrees of air pollution.

Cook Inlet gas is a clean fuel that causes few serious air pollution problems at the present time. The existing gas turbines have very low efficiencies and give off visible water vapor emissions during the colder winter months. Also, nitrogen emissions could be of significant concern for any proposed larger gas-fired plants.

Hydroelectric energy could replace the burning of fossil fuels for electric power generation in much of the Fairbanks area and could help to alleviate winter ice fog and smoke problems, which are caused in part by coal-fired electrical plants in that area.

Hydroelectric projects provide a very clean source of power with practically no direct air pollution-related problems. This type of electrical power generation could reduce a substantial amount of future air pollution problems associated with the burning of gas, oil, and coal.

An ice-free stretch of warmer, open water below Devil Canyon Dam could cause ice-fog conditions in that area during periods of extreme cold weather.

Social:

Population: Substantial increases in population are expected within the Southcentral Railbelt area through the year 2000, and with the possible relocation of Alaska's State capital from Juneau to the Railbelt, an additional population impact can be expected in this area.

The population of the area will increase with or without the development of hydroelectric projects proposed for the Susitna River;

construction of the project is not expected to have any significant effect on overall population growth.

Economics: The proposed two-dam Devil Canyon-Watana hydroelectric development would have a minimal to moderate overall effect depending on various factors involved in the construction program itself. If the construction unit is brought in from outside Alaska to develop the project, the social and economic impact on the local system would be minimized, but if the project were constructed using substantial labor and material from the Anchorage-Fairbanks area, it would have a more moderate effect on local conditions during construction of the project and would help to stabilize economic conditions during that development period. It is projected that about 80 percent (878 out of 1,097 workers) of the labor force would be local and that half (439 workers) of that is labor that would otherwise be un- or underemployed. The resulting benefit to such labor is the source of Area Redevelopment benefit.

Various community, borough, State, and private facilities and agencies would be impacted to varying degrees by the workers involved in the construction of the proposed project. Workers' camps would be built in the vicinity of some of the various construction activities, but additional impacts would be created by the families of the construction workers living in various nearby communities, who would require additional facilities and services.

After the construction of the project, an estimated 45 permanent personnel would be required to operate and maintain the project and project-related facilities--these people would not create a significant overall socioeconomic impact on the Railbelt area.

Other Effects: The lands within the reservoir areas have sporadic occurrences of permafrost. The lakes would thaw such material to a considerable depth and increase the probability of earthslides and erosion of the material. However, the overburden depth to rock is quite shallow throughout most of the sharply incized canyon terrain of the two reservoirs and the quantities of materials which would be involved in such slides and/or erosion are thus not considered significant either in terms of reservoir sedimentation or in the creation of large waves of danger to the dams. It is estimated that of the 210 miles of combined shoreline, 40 miles could experience significant erosion, while the remaining 170 miles would be subject to only minor effects. The effects of even the severe erosion would be expected to last only a few years until the thawed and saturated slopes had attained equilibrium.

Response to Study Objectives: The response of the Devil Canyon-Watana hydropower alternative to the study objectives is summarized as follows:

Power: Provides 6.91 billion kilowatt-hours average annual energy. Meets the projected demand until the mid-1990's.

Flood Control: Provides minor flood control benefits.

Air Pollution: Provides partial air pollution abatement by displacing and or delaying increased use of coal in Railbelt area.

Fish and Wildlife: Direct loss of 50,550 acres of land including 2,100-3,100 acres of critical winter moose habitat. Possible adverse effect on caribou migration and anadronous fish. Probable creation of 300-400 acres of replacement moose habitat. Possible contribution to establishment of non-migration fish population. Provides 50,550 acres of possible waterfowl resting area.

Recreation: Provides light use recreational facilities equivalent to 77,000 visitor days. Adverse effect on 9 miles of whitewater boating potential.

Conservation of Nonrenewable Resources: Conserves equivalent of 5.85 million tons of coal annually.

Energy Independence: Conserves equivalent of 112.9 billion cubic feet of natural gas, or 15.2 million barrels of oil annually.

Devil Canyon-Watana-Denali: This alternative would be identical to the previous two-dam system except for the addition of a 260-foot-high earthfill dam at river mile 248 near Denali. This dam would provide an additional storage area of 54,000 acres, and would have no powerhouse. The first cost of the three-dam system is estimated as $1.89 billion. Annual costs are estimated as $115,566,000, including $2,600,000 for operation, maintenance, and replacements. Average annual project benefits accrue as follows:

Power	$133,922,000
Recreation	300,000
Flood Control	50,000
Area Redevelopment	10,905,000
Total	$145,177,000

The B/C ratio is 1.3 to 1.
Net annual benefits are $29,611,000.

The system would have an average annual energy output of 6.91 billion kilowatt-hours and a firm energy output of 6.80 billion kilowatt-hours from an installed capacity of 1,552 MW. The project cost of energy to the distributors would be 21.0 mills per kilowatt-hour.

Project effects would be essentially identical to the two-dam project, except as follows:

River Flows: Average regulated downstream flows at Devil Canyon would range from about 8,900 cfs in October to 11,000 cfs in February. In extreme years, the flows would range from 7,800 cfs to 16,000 cfs. Overall, the effect would be to provide better river regulation. Flood control would remain essentially unchanged with flood control benefits identical.

Water Quality: Devil Canyon reservoir would remain unchanged. Watana reservoir would receive less heavy sediment, approximately 3.5 million tons per year rather than 7.1 million tons per year. Denali reservoir would have a high pool surface area of 54,000 acres and would fluctuate an average of 30 to 40 feet annually to a low surface area of 35,000 acres. The reservoir would be 34 miles long and 6 miles wide at high pool. The pool would force relocation of 19 miles of the Denali Highway.

Fish: Resident fish would be severely impacted by the fluctuating pool. Some might survive in the tributary streams at low pool, but many would be trapped in temporary pools and die during drawdown. Downstream effects on anadromous fish would be identical to the preceding plan. Adverse effects to resident fish in Watana reservoir could be increased marginally since the fluctuation of that reservoir would be increased from 95-120 feet annually to 110-140 feet, providing a less favorable environment. Stocking of Denali reservoir would probably be nonbeneficial in that the pool fluctuations would have the same adverse effects on these fish as on fish now resident to the tributary streams.

Wildlife: The impacts on wildlife would be increased greatly. Of the 54,000 acres inundated by Denali reservoir, an estimated 52,000 acres are moist tundra and pothole lakes which provide moderate habitat to moose and are highly significant as caribou habitat. In addition, the lakes, estimated to number about 400, provide significant resting and nesting for waterfowl. Effects at the two downstream dams would not be significantly changed. Human access, via the reservoir at full pool, would be improved to the headwater areas of the Susitna River. The major ecosystem in these areas, alpine tundra, is quite fragile and could be adversely impacted if access were not carefully regulated. The Denali reservoir would have a high water shoreline about 100 miles long. However, because of the frequent and rapid pool fluctuations, little beneficial habitat could be expected to develop.

Recreation: The Denali reservoir could have significant adverse impacts on present recreational uses made of the area. Moose and caribou hunting in this area now accessible by the Denali Highway provides a large part of the present recreational activity in the Upper Susitna River Basin. Establishment of the reservoir, by removing much of the suitable habitat of the game animals, would greatly reduce the hunting opportunities. Because of the fluctuations in the reservoir level and the resulting unfavorable conditions for fish, little if any replacement recreational opportunity would be provided to offset this loss. No recreational facilities would be provided at the reservoir in view of the unfavorable conditions.

Historic and Archaeological Sites: In addition to the single site of historic interest and 40 zones of archaeological interest contained in the two-dam system, the Denali reservoir would emcompass 20 archaeological zones of interest and 3 potential historical sites.

Mining: The area adjacent to the Denali reservoir has a long and continuing history of gold mining. Although no active mines would be inundated by the reservoir, further exploration and/or development within the confines of the impoundment would be hampered or precluded.

Transmission System: Because Denali Dam would have no generation capacity, no additional transmission lines or effects would result.

Roads: In addition to the effects of the two-dam system, there would be a required relocation of about 19 miles of the Denali Highway. The temporary construction access roads would, for the most part, be merged into the permanent road. The most significant effects of the relocation would be loss of about 200 additional acres of wildlife habitat and better access to the damsite vicinity, which could impose added pressures on wildlife.

Construction Activities: The general effects would be those listed for the two-dam system with the addition of an estimated three to four years of such activity at the Denali site.

Workers' Facilities: Construction of a Denali Dam would require a temporary camp for about 600 workers since the only nearby settlements, Denali and Paxson, do not have facilities which could absorb the workforce. The impacts and controls required would be the same as listed for the two-dam system.

Esthetics: The Denali Dam and reservoir, with the Denali Highway crossing the dam structure itself, would be highly visible to all motor traffic. The reservoir at less than full pool would have a definite adverse impact on the scenic values of the area. Because of the generally flat terrain within the reservoir, even a few feet of fluctuation in the pool level would create a wide "bathtub ring" of defoliated shore. At large drawdowns, the ring could be a mile or more in width.

No means of preventing or significantly lessening the impact of this feature is compatible with the power production objective which requires the drawdown.

Air Pollution: Except for the short-term effects of construction activities at Denali Dam, the effects of the three-dam system would be identical to the two-dam system.

Social: The effects would be the same as for the two-dam system except that additional employment would be provided. The increased Area Redevelopment benefits reflect the additional use of un- or under-employed labor in the construction of the additional dam and facilities. As previously stated, the addition of the Denali Dam would result in an increase of 4, from 45 to 49, in permanent jobs created in operation and maintenance of the dam system. The construction of permanent living quarters at the damsite might be foregone in favor of locating the personnel at Paxson.

Other Effects: The Denali reservoir area is underlain by permafrost. Inundation would cause a significant thawing of this material. Because of the very flat terrain, earthslides should not be of consequences. However, the materials are generally very fine-grained and when thawed and saturated could have poor structural integrity when subjected to earthquakes. As such, the materials pose a difficult technical problem in the design of a Denali Dam. The cost of adequate remedial foundation treatment for the structure is a significant factor in the overall cost of what would otherwise be a relatively small dam. Erosion of the thawed shoreline would not contribute significantly to sedimentation of the reservoir. It is estimated that all of the 100-mile shoreline could be subject to severe erosion until equilibrium was restored and vegetation reestablished.

Response to Study Objectives: The response of the Devil Canyon-Watana-Denali hydropower alternative to the study objectives is summarized as follows:

Power: Provides 6.91 billion kilowatt-hours average annual energy. Meets the projected demand until the mid-1990's.

Flood Control: Provides minor flood control benefit.

Air Pollution: Provides partial air pollution abatement by displacing and/or delaying increased use of coal in Railbelt area.

Fish and Wildlife: Direct loss of 104,550 acres of land, including 2,100-3,100 acres of critical winter moose habitat, and 52,000 acres of important caribou habitat and waterfowl nesting area. Possible adverse effects on caribou migration and anadromous fish. Probable creation of 300-400 acres of replacement moose habitat. Possible contribution to establishment of nonmigratory fish population. Provides 104,550 acres of possible waterfowl resting area.

Recreation: Provides light use recreational facilities equivalent to 77,000 visitor days. Adverse effect on 9 miles of whitewater boating potential. Probable adverse effect on recreational hunting and fishing in 54,000-acre Denali reservoir.

Conservation of Nonrenewable Resources: Conserves equivalent of 5.85 million tons of coal annually.

Energy Independence: Conserves equivalent of 112.9 billion cubic feet of natural gas, or 15.2 million barrels of oil annually.

Devil Canyon-Watana-Vee-Denali: This alternative would consist of the previously described dams at Devil Canyon and Denali with a lower (515 feet vs 810 feet) earthfill Watana Dam and a 455-foot-high earthfill dam in Vee Canyon at the extreme head of Watana reservoir at river mile 208. The three downstream dams would have powerhouses and switchyards. An additional 40 miles of access road would connect Vee Dam to Watana Dam. An additional 40 miles of transmission line would also be required to connect Vee Dam to the downstream system. The dam would have a visitor center, a boat ramp, and limited recreational facilities. The project first cost is estimated as $1.95 billion. Annual costs are estimated as $102,491,000, including $3,200,000 for operation, maintenance, and replacements. Average annual project benefits accrue as follows:

Power	$107,865,000
Recreation	400,000
Flood Control	50,000
Area Redevelopment	10,971,000
Total	$119,286,000

The B/C ratio is 1.2 to 1.
Net annual benefits are $16,795,000.

The system would have an average annual energy output of 6.88 billion kilowatt-hours and a firm energy output of 6.15 billion kilowatt-hours from an installed capacity of 1,404 MW. The projected energy cost to the distributors would be 24.3 mills per kilowatt-hour.

Project impacts of the Devil Canyon, Watana, and Denali Dams would be essentially as described previously, except that Watana reservoir would have an area of only 14,000 acres. Because the most favorable wildlife habitat is in the vicinity of the stream-river confluences, there would be essentially the same losses of critical winter moose habitat as with the higher dam and larger reservoir. Vee reservoir, about 9,400 acres in extent, would impose the following additional impacts.

River Flows: Average regulated downstream flows at Devil Canyon would range from about 7,900 cfs in October to about 12,200 cfs in August. In extreme years, the flows would range from 5,800 cfs in October to 23,000 cfs in August. River regulation would be somewhat better than that of the two-dam system and not as good as that of the three-dam system. Flood control benefits would be identical in origin and value to the other plans.

Water Quality: Sediment entrapment at Watana reservoir would decrease further to 2.0 million tons per year from the 3.5 million tons per year of the three-dam system, the difference being the entrapment of Vee reservoir. All other downstream water quality effects would remain essentially unchanged.

Fish: The lower Watana reservoir level would offer less opportunity for allowing resident fish to get to the upper tributaries above the steep sections of these tributaries which now bar use of this possible habitat. In addition, Vee reservoir would flood the mouth of Tyone River with a fluctuating and turbid pool and would, in all likelihood, severely decrease the present resident fish population of this, the main clearwater tributary of the upper Susitna River. Fluctuations in Watana reservoir would be decreased to an average of 80-95 feet, which might offer potential for establishment of a lake-oriented fish populace by stocking. Simultaneously, fluctuation of Denali reservoir would increase to an average of 40-60 feet. No change would occur in effects on fish below the system of dams.

Wildlife: The addition of Vee reservoir to the system would have a significant impact on wildlife. About 7,000 acres of the 9,400-acre reservoir are lowland spruce-hardwood, which is prime moose habitat and favorable for smaller mammals because of its diverse vegetation. The inundated lands are much less precipitous than those of the Devil Canyon and Watana reservoirs and are not only more favorable for, but are much more heavily used by wildlife, especially by moose. In addition, if the reservoir systems should prove to be a barrier to traditional caribou migration routes, forcing the caribou to go around them, Vee reservoir would increase the detour mileage from 25 to 45 miles from the Kosina Creek-Jay Creek vicinity. The Vee reservoir would have a high-water shoreline about 100 miles long. Because of the large and frequent pool fluctuations, little beneficial habitat could be expected to develop.

Recreation: Vee reservoir would increase the recreational potential of Watana reservoir by reducing the fluctuation level of that impoundment. The Vee impoundment and the additional access provided by the necessary roads would provide added recreational opportunity in themselves, although the Vee reservoir would have an average drawdown of 90-100 feet. As with the two downstream reservoirs, low density fishing, boating, hiking, and camping use would be most in keeping with the land and location. An increase in use days to about 100,000 (from 77,000) would give recreational benefits estimated at $400,000 annually.

Improved access would also tend to increase hunting pressures in the area extending from Watana Dam to Vee reservoir. As a result, added pressures would also be placed on responsible agencies to insure proper resource management.

Historic and Archaeological Sites: The area at and around the mouth of Tyone River has a long history of occupation and use by man. Vee reservoir would affect 25 zones of potential archaeological interest, by far the most of any single reservoir studied. Representatives of the native people of the region have indicated that the Tyone River confluence with the Susitna River is a long-used and valued area which they would not care to see disturbed. Construction of the reservoir would benefit archaeological knowledge in that it would spur exploration of that area; however, it would adversely affect both the interests of the native peoples and future possible archaeological explorations.

Mining: The Vee reservoir would, in itself, have little probable effect on mining potential beyond that of the other impoundments of the system, especially Denali reservoir.

Transmission System: An additional 40 miles of transmission line to connect Vee Dam and powerhouse to the system downstream would be required. This would involve additional clearing and disturbance of approximately 900 acres. The effects of this would be the same as for the rest of the transmission route in type, but would be increased in proportion to the added line length.

Roads: An additional 40 miles of access road would also be required for the Vee Dam. This would require approximately 500 additional acres of habitat loss and disturbance of wildlife. This particular section of road would intersect the general caribou migration routes in the Kosina-Jay Creeks vicinity. Although the road should pose no bar to migration, there would be possible interference between the animals and humans inasmuch as the road would be open to vehicles during the summer when the northward movement of the herd could be expected.

Construction Activities: The type of effects would be the same as for Devil Canyon and Watana Dams. Vee Dam would prolong the period of effects by about five more years.

Workers' Facilities: As with the preceding systems, no existing communities could absorb the project workforce. Commuting distance from the nearest established camp facility, Watana Dam, would be too great for economical use of these facilities. Thus, a temporary camp would be required in the vicinity of the damsite. The effects would be identical and additive to those previously described for the two-and three-dam systems.

Esthetics: The previously discussed adverse visual impacts would be increased. The "bathtub ring" at Denali reservoir would be increased by the added drawdown. The Vee reservoir area, not so much the steep canyon sections downstream of Oshetna River, but the more gently sloped, rolling terrain in the Tyone River and upstream area, would acquire a similar ring of defoliated barren land which would decrease the scenic value drastically. These would be additions to the downstream effects described for the other systems.

Air Pollution: Except for the short-term effects during construction of Vee Dam, the effects of the four-dam system would be identical to the three-dam system.

Social: The effects would be the same as for the two- and three-dam systems except that additional employment would be provided. The Area Redevelopment benefits from this plan reflect the increase in use of un- or underemployed labor over the other plans. Facilities would have to be provided at the dam for permanent operating personnel. It is estimated that 10 additional permanent jobs would be created by construction of Vee Dam, raising the system total to 59.

Other Effects: The effects of the reservoir on underlying permafrost would be a combination of the effects at the downstream reservoirs and the Denali impoundment since the Vee reservoir would lie in part in steep canyons with shallow frozen overburden and in part in flatter terrain similar to the Denali area. No significant reservoir sedimentation or slide-caused waves would be expected. Significant shoreline erosion would be expected to affect about 35 miles of the shoreline for a few years until an equilibrium condition was reached.

Response to Study Objectives: The response of the Devil Canyon-Watana-Vee-Denali hydropower alternative to the study objectives is summarized as follows:

Power: Provides 6.88 billion kilowatt-hours average annual energy. Meets the projected demand until the mid-1990's.

Flood Control: Provides minor flood control benefits.

Air Pollution: Provides partial air pollution abatement by displacing and/or delaying increased use of coal in Railbelt area.

Fish and Wildlife: Direct loss of 84,950 acres of land including 9,100-10,100 acres of critical winter moose habitat, and 52,000 acres of important caribou habitat and waterfowl nesting area. Possible adverse effects on caribou migration and anadromous fish. Probable creation of 300-400 acres of replacement moose habitat. Possible contribution to establishment of non-migratory fish population. Provides 84,950 acres of possible waterfowl resting area.

Recreation: Provides light use recreational facilities equivalent to 100,000 visitor days. Adverse effect on 9 miles of whitewater boating potential. Probable adverse effect on present hunting-fishing use of Tyone River confluence.

Conservation of Nonrenewable Resources: Conserves equivalent of 5.83 million tons of coal annually.

Energy Independence: Conserves equivalent of 112.2 billion cubic feet of natural gas, or 15.1 million barrels of oil annually.

NED PLAN

From the preceding evaluations, it is concluded that the system comprised of dams at the Devil Canyon and Watana sites best accomplishes the objective of maximizing National Economic Development. The two-dam system has the highest B/C ratio at 1.3 and the maximum net benefits at $33,856,000 annually while producing electrical energy equal to any of the other plans.

EQ PLAN

From the preceding evaluations, it is evident that no means of producing a meaningful output of electrical energy was found to be free of significant adverse environmental effects. The plan which minimizes the unavoidable adverse impacts on fish and wildlife values while providing beneficial contributions to air and water quality and social well-being is considered to contribute most to the Environmental Quality objectives. On this basis, the system of two dams at Devil Canyon and Watana is also the EQ plan.

THE SELECTED PLAN

The two-dam Devil Canyon-Watana system is selected as the plan providing the best overall response to the study objectives. The following table displays a summary comparison of the significant facts and factors which guided formulation of the selected plan.

THE SELECTED PLAN

The selected plan, shown on Plate 1, consists of a two-dam development on the upper Susitna River. The Devil Canyon damsite is located at river mile 134, about 14.5 miles upstream from Gold Creek, the closest point on the Alaska Railroad. The Watana damsite is located at river mile 165, approximately 2 river miles upstream from the upper limit of the Devil Canyon reservoir. Watana Dam will be constructed first.

WATANA DAM FEATURES

The main dam, shown on Plate 2, consists of an earthfill structure 810 feet high with a crest length of 3,200 feet. The upstream side slope is 1 on 2.5 and a downstream side slope of 1 on 2, and the crest elevation is 2,210 feet, msl. The dam was designed for earthquakes using a Maximum Credible Earthquake (MCE) of magnitude 8.5 on the Richter Scale, originating at the Denali Fault 40 miles to the north. Consideration was given to the effects of a lesser magnitude (6.0) earthquake originating at the short Susitna Fault 2-1/2 miles east of the damsite.

The saddle spillway is 210 feet wide with a low ogee crest at elevation 2162 feet, msl. The spillway is controlled with three 59-foot x 42-foot tainter gates. Routing of the design flood through the spillway resulted in a maximum discharge of 193,000 cfs at a reservoir pool elevation of 2205 feet, msl.

The intake structure is approximately 370 feet high and is located on the left bank about 700 feet upstream from the dam. It has multi-level intake portals sized to pass a discharge of 24,500 cfs.

The diversion plan at the damsite consists of two intake structures in the right abutment, one at elevation 1925 and the other at elevation 1725, which join the two 30-foot horseshoe diversion tunnels near the dam axis. Each of the tunnels is about 4,000 feet long. The facilities will provide protection of the construction site for a 20-year frequency flood estimated to be 72,000 cfs and allow reservoir drawdown under emergency conditions.

The Watana powerplant is located in an underground chamber in the left abutment and will house three 236-MW generating units and three 324,000-horsepower Francis turbines. The powerhouse chamber will also contain transformers, two 600-ton cranes, machine shop, and other necessary equipment. Vehicle access to the powerplant is provided by a service road 1.9 miles long, including a 2,100-foot tunnel.

SUMMARY COMPARISON OF ALTERNATIVE PLANS

	PLAN A	PLAN B	
	WITHOUT CONDITION	NATIONAL ECONOMIC DEVELOPMENT (NED) ENVIRONMENTAL QUALITY (EQ) PLANS	MA
	Conventional Coal Thermal Plant	Devil Canyon-Watana Dams	De
A. PLAN DESCRIPTION	Non-Federal financing of a 300-mw coal-fired generating plant at Healy and a 1,200-mw coal-fired plant at Beluga. The plants would have 35-year service lives. Project would include costs for coal mining and separate Healy-to-Fairbanks and Beluga-to-Anchorage transmission systems.	Federal financing of the total system to include a thin-arch dam and underground powerplant at the Devil Canyon site, and an earthfill dam and underground powerplant at the Watana site. Both projects would provide at-site power generation. Watana would provide the seasonal storage for the system. Plan would also include transmission system between projects and to the Anchorage and Fairbanks load centers.	This pla Plan B, Denali F power ge for low downstre
1. Dam Heights	No Dams	1. Devil Canyon - 635 feet 2. Watana - 810 feet	1. Devi 2. Wata 3. Dena
2. Dependable Capacity	1,500,000 kilowatts	1,394,000 kilowatts	
B. SIGNIFICANT IMPACTS	(Included in Relationship to Four Accounts)	(Included in Relationship to Four Accounts)	(Include Accounts
C. PLAN EVALUATION			
1. Contribution to Planning Objective			
a. Firm Annual Energy	6,800,000,000 kilowatt-hours	6,100,000,000 kilowatt-hours	
b. Average Annual Energy	6,910,000,000 kilowatt-hours	6,910,000,000 kilowatt-hours	
c. Percent of Basin Potential	Not Applicable	96%	
d. System Dependability	No grid intertie of major load centers. Reduced dependability.	Provides grid intertie of major load centers.	Provides centers
2. Relationship to Four Accounts			
a. National Economic Development (NED)			
NET NED BENEFITS	0	$33,856,000	
BENEFIT-TO-COST RATIO	1.0	1.3	
b. Environmental Quality (EQ)			
Acreage Inundated or Destroyed	20,000	50,550	
Drawdown Zone Acreage	0	13,000	
Stream Mileage Inundated or Degraded	110-120	82	
Whitewater Mileage Inundated	0	9	
Major Ecosystems, Acreage Inundated or Destroyed			
Important Moose Habitat	18,000	4,000	
Important Caribou Habitat	2,000	0	
Important Waterfowl Habitat (number of pothole lakes)	2,000 acres	0	
Archaeological Zones Precluded from Post-Construction Studies	Unquantified area has very high potential	40	
Prehistoric Sites Inundated or Destroyed	0	0	
Historic Sites Inundated or Destroyed	0	1	
c. Social Well-Being (SWB)			
Energy Resources Conserved in Tons per Year		5,850,000	
d. Regional Development (RD)			
Cost of Power in Mills/Kwhr	26.4 - 31.4	21.1	
3. Plan Response to Associated Evaluation Criteria			
a. Acceptability	This plan is the worst from the standpoint of conservation of nonrenewable resources. It has large adverse EQ effects in that it requires strip-mining of 20,000 acres of important wildlife habitat, it degrades water quality by chemical inputs and suspended sediments, and it degrades air quality by inputs of particulates and chemical pollutants. Its NED performance is acceptable. It provides no flood control or recreational opportunity.	Maximum beneficial impacts of options studied in NED and EQ accounts. Supported by consensus of most publics. Plan has drawn some concern because of possibility for induced population growth associated with initial power on line, as well as the adverse impact on fish and wildlife values. Would provide flood control and recreation potential.	Greater recommen the reco Would pr hydro de flood co

	PLAN B	PLAN C	PLAN D
DITION	NATIONAL ECONOMIC DEVELOPMENT (NED) ENVIRONMENTAL QUALITY (EQ) PLANS	MAXIMUM POWER DEVELOPMENT PLAN	PREVIOUSLY RECOMMENDED PLAN
Thermal Plant	Devil Canyon-Watana Dams	Devil Canyon-Watana-Denali Dams	USBR Four-Dam System
of a 300-mw coal- at Healy and a ant at Beluga. 35-year service include costs for te Healy-to- o-Anchorage trans-	Federal financing of the total system to include a thin-arch dam and underground powerplant at the Devil Canyon site, and an earthfill dam and underground powerplant at the Watana site. Both projects would provide at-site power generation. Watana would provide the seasonal storage for the system. Plan would also include transmission system between projects and to the Anchorage and Fairbanks load centers.	This plan is basically the same as the Plan B, but with the addition of the Denali Project would have no at-site power generation and would be used only for low flow augmentation of the two downstream projects.	This is the system proposed by the Bureau of Reclamation in its 1952 report on hydropower resources of the Upper Susitna River Basin. Federal financing of the total system to include a thin-arch dam and powerplant at the Devil Canyon site, a low head earthfill dam and powerplant at the Watana site, an earthfill dam and powerplant at the Vee site, and a flow augmentation reservoir at the Denali site. Plan would also include transmission system between projects and to the two load centers.
	1. Devil Canyon - 635 feet 2. Watana - 810 feet	1. Devil Canyon - 635 feet 2. Watana - 810 feet 3. Denali - 260 feet	1. Devil Canyon - 635 feet 2. Watana - 515 feet 3. Vee - 455 feet 4. Denali - 260 feet
atts	1,394,000 kilowatts	1,552,000 kilowatts	1,404,000 kilowatts
hip to Four	(Included in Relationship to Four Accounts)	(Included in Relationship to Four Accounts)	(Included in Relationship to Four Accounts)
ilowatt-hours ilowatt-hours	6,100,000,000 kilowatt-hours 6,910,000,000 kilowatt-hours 96%	6,800,000,000 kilowatt-hours 6,910,000,000 kilowatt-hours 96%	6,150,000,000 kilowatt-hours 6,880,000,000 kilowatt-hours 95%
jor load centers.	Provides grid intertie of major load centers.	Provides grid intertie of major load centers.	Provides grid intertie of major load centers.
	$33,856,000 1.3	$29,611,000 1.3	$16,795,000 1.2
	50,550 13,000 82 9	104,550 45,000 116 9	84,950 45,000 138 9
  res	4,000 0 0	4,000 52,000 400	10,000 52,000 400
very high	40	60	85
	0	0	1
	1	4	4
	5,850,000	5,850,000	5,830,000
.4	21.1	21.0	24.3
t from the stand- of nonrenewable rge adverse EQ quires strip- s of important degrades water nputs and suspended rades air quality ates and chemical performance is des no flood al opportunity.	Maximum beneficial impacts of options studied in NED and EQ accounts. Supported by consensus of most publics. Plan has drawn some concern because of possibility for induced population growth associated with initial power on line, as well as the adverse impact on fish and wildlife values. Would provide flood control and recreation potential.	Greater adverse EQ effects than in recommended plan. Ranks second to the recommended plan in the NED account. Would provide maximum firm power of hydro development plans. Would provide flood control and recreation potential.	Beneficial impacts in NED, SWB, and RD accounts. Has good potential for stage development of hydro projects and is plan favored by Alaska Power Administration. Ranks low in the EQ account in comparison to other alternatives. Would provide flood control and recreation potential.

SUMMARY COMPARISON OF ALTERNATIVE PLAN (continued)

	PLAN A	PLAN B	
	WITHOUT CONDITION	NATIONAL ECONOMIC DEVELOPMENT (NED) ENVIRONMENTAL QUALITY (EQ) PLANS	MAXIMUM E
	Conventional Coal Thermal Plant	Devil Canyon-Watana Dams	Devil Ca
C. PLAN EVALUATION (Cont.)			
3. Plan Response to Associated Evaluation Criteria (Cont.)			
b. Certainty	This appears to be an implementable plan which could be pursued to meet energy needs for the near and long range future. It is the most flexible plan in terms of incremental development and operation potentials.	Foundation conditions appear adequate for construction of both projects. Transmission system is within the means of present technology. Least flexible of alternatives to changes in projected power demand.	S . evaluati s . ge contr Additional exp this structur More flexible
c. Completeness	Could match the energy output of any plans evaluated herein as long as fuel source is available.	Provides adequate power to satisfy projected demand growth until mid-1990's. Little potential for expansion. Demand beyond the project capability will have to be met by other development.	Provides adequ projected dema Little potenti beyond the pro to be met by
d. Effectivensess	Could be expanded indefinitely to limits of fuel.	Would develop 96 percent of basin development potential.	Develops grea to Plan B in
D. IMPLEMENTATION RESPONSIBILITY			
1. Financial Responsibility	Private and/or semi-public entities coordinated with Federal and State regulatory agencies.	Federal Government with power marketed through the Alaska Power Administration.	Federal Gover through the A
2. Recreation Sponsorship	None	State of Alaska	State of Alask

PLAN A	PLAN B	PLAN C	PLAN D
OUT CONDITION	NATIONAL ECONOMIC DEVELOPMENT (NED) ENVIRONMENTAL QUALITY (EQ) PLANS	MAXIMUM POWER DEVELOPMENT PLAN	PREVIOUSLY RECOMMENDED PLAN
al Coal Thermal Plant	Devil Canyon-Watana Dams	Devil Canyon-Watana-Denali Dams	USBR Four-Dam System
o be an implementable plan pursued to meet energy near and long range the most flexible plan cremental development and ntials.	Foundation conditions appear adequate for construction of both projects. Transmission system is within the means of present technology. Least flexible of alternatives to changes in projected power demand.	Same evaluation as for Plan B except for storage control project at Denali site. Additional explorational required before this structure could be recommended. More flexible than Plan B.	Same evaluation as for Plan C except for the power project at the Vee site. Additional exploration of abutment material required before this dam could be recommended for the structural height stated above. Most flexible of hydro alternatives.
e energy output of any d herein as long as fuel lable.	Provides adequate power to satisfy projected demand growth until mid-1990's Little potential for expansion. Demand beyond the project capability will have to be met by other development.	Provides adequate power to satisfy projected demand growth until mid-1990's Little potential for expansion. Demand beyond the project capability will have to be met by other development.	Provides adequate power to satisfy projected demand growth until mid-1990's. Little potential for expansion. Demand beyond the project capability will have to be met by other development.
ded indefinitely to .	Would develop 96 percent of basin development potential.	Develops greatest firm power - equal to Plan B in average annual power.	Would develop 95 percent of basin development potential.
semi-public entities th Federal and State ncies.	Federal Government with power marketed through the Alaska Power Administration.	Federal Government with power marketed through the Alaska Power Administration.	Federal Government with power marketed through the Alaska Power Administration.
None	State of Alaska	State of Alaska	State of Alaska

2861-76

A cost comparison between an above ground versus an underground powerplant at the Watana damsite showed that the underground plant was less expensive. This and other factors, such as severe winter weather conditions, short construction season, higher maintenance costs, and scarcity of a good above ground powerplant site location, led to the selection of the underground powerhouse.

The Watana switchyard is placed on the left bank of the Susitna River just downstream of the dam. The switchyard is approximately 700 feet by 500 feet, and at elevation 2100 feet, msl.

A large portion of the lands within the Watana reservoir area was withdrawn for power purposes in February 1958 by Powersite Classification No. 443. The powersite withdrawal for Watana includes all lands below the 1910-foot contour. However, access roads, transmission corridors, and some other project features, as well as additional lands required for the larger reservoir, were not included in the withdrawal. There are no existing roads, railroads, or other improvements affected by the reservoir impoundment. The additional lands required are estimated at 35,000 acres.

Watana reservoir would have a surface area of 43,000 acres at normal full pool elevation of 2,200 feet. The normal minimum power pool level would be at elevation 1950, while the maximum elevation produced by the design flood would be 2,205 feet. The reservoir will extend about 54 miles upstream to above the confluence of the Oshetna River.

A 24-foot-wide access road, designed to AASHO standards, will connect the damsites to the Parks Highway near Chulitna. A 650-foot-long bridge will be required to cross the Susitna River downstream of Devil Canyon. Devil Canyon damsite will be near mile 27 of the 64-mile road to Watana.

A subsidiary purpose in the construction of the electric transmission line will be the interconnection of the two largest electrical power distribution grids in the State of Alaska, which will result in increased reliability of service and lower cost of power generation.

Most of the power generated would be used in the Fairbanks-Tanana Valley and the Anchorage-Kenai Peninsula areas. The transmission system proposed would consist of two 198-mile, 230 kv single circuit lines from Devil Canyon switchyard to Fairbanks (called the Nenana corridor), and two 136-mile, 345 kv single circuit lines from the switchyard to the Anchorage area (called the Susitna corridor). Power would be carried from Watana to Devil Canyon by two 30-mile, 230 kv transmission lines. Total length of the lines would be 364 miles. Transmission line corridors would require a right-of-way totaling about 8,200 acres. The cleared portion would be 186-2[illegible] feet wide and total about 6,100 acres.

Towers would be either steel or aluminum, and of free-standing or guyed type, depending upon final design and local conditions.

Tentative sites have been selected for the temporary trailer-modular dormitory construction camp as well as for permanent facilities. Operation and maintenance facilities at the damsite include a 50-foot by 100-foot warehouse, a vehicle storage building, and permanent living quarters.

DEVIL CANYON DAM FEATURES

The main dam, shown on Plate 3, consists of three integral sections: (1) a 635-foot-high concrete, double curvature, thin-arch section with crest length of 1,370 feet; (2) a 110-foot-high concrete thrust block section with crest length of 155 feet; and (3) a 200-foot-high fill section in the left abutment with a 950-foot crest length. An earthquake stability analysis was made based on the same 8.5 MCE as for Watana.

The intake structures will be integral with the arch dam. They will be gated to provide selective withdrawal at intervals between elevations 1,100 and 1,400. The chute spillway is placed in the left abutment between the thrust block and fill sections of the dam. The spillway design flood is 222,000 cfs. The spillway will have an ogee crest at elevation 1395 with two 64-foot by 60-foot gates. The chute will terminate in a superelevated flip bucket at elevation 1110, which will discharge parallel to the river. This spillway design should minimize nitrogen supersaturation as well as riverbed erosion.

The outlet works consist of four 11-foot by 7-1/2-foot gated sluiceways at elevation 1075, which will have a minimum discharge capacity of 21,000 cubic feet per second at a 75-foot head. Each sluiceway ends in a flip lip to project water away from the dam toe. The outlet works are adequate to meet emergency drawdown requirements.

The Susitna River will be diverted through a 1,150-foot-long, 26-foot concrete-lined horseshoe tunnel located in the left abutment. Cellular cofferdams will be constructed upstream and downstream of the dam to provide protection of the construction site against the Watana Dam power flows of 20,000 cubic feet per second.

The Devil Canyon powerhouse is located in an underground chamber in the right abutment. Initially, four 171-MW generating units are to be installed with four 234,000-horsepower Francis turbines. The powerhouse will also contain two 425-ton cranes, service areas, and a machine shop for equipment maintenance and repair. A separate upstream underground chamber will house transformers and circuit breakers.

Vehicle access to the powerplant is provided by a service road across the top of the dam and an all-weather road on the right side of the river. The road will be 2.3 miles long including a 2,100-foot tunnel.

The Devil Canyon switchyard is located on the left bank of the river immediately downstream of the rockfill section of the dam.

The major portion of tne lands within the reservoir area were withdrawn for power purposes in 1958. The Devil Canyon Dam powersite withdrawal includes all lands below the 1,500-foot contour elevation. Devil Canyon reservoir would have a surface area of 7,550 acres at normal full pool elevation of 1,450 feet. The minimum power pool level would be at elevation 1,275, while the maximum elevation produced by the design flood would be 1,455 feet. The reservoir would extend about 28 miles upstream to about 2 miles below the Watana damsite. The reservoir area, confined within the Susitna River canyon, is narrow.

Devil Canyon damsite will be 27 road miles from the Parks Highway and 37 road miles from Watana.

Tentative sites have been selected for temporary construction camps as well as for permanent facilities for operating personnel. The temporary construction camps will consist of units reused from the construction of Watana Dam.

OPERATION PLAN

For study purposes the reservoirs were operated to provide optimum power operation during the average year. To maintain maximum powerhead, Devil Canyon was given priority by providing storage releases from Watana as necessary. Watana was operated to maintain the Devil Canyon maximum pool and to provide additional capacity and energy.

During the first five years of operation, prior to the completion of the Devil Canyon project, Watana would be operated to provide capacity and generation as demanded to the limits of its capability. Full pool conditions would usually occur during the summer months of July through October (the most severe historic floods have usually occurred during the spring snowmelt of May and June). Devil Canyon reservoir is expected to remain full almost 100 percent of the time.

CONSTRUCTION SCHEDULE

Construction Season: The outdoor construction season at Devil Canyon and Watana damsites is about six months and could be extended by careful scheduling, planning, and the use of temporary, heated enclosures where construction situations would permit.

Preconstruction Planning for the Selected Plan: A period of about four years is estimated for preconstruction planning. The work scheduled for this period includes an economic reanalysis, detailed environmental and archaeological surveys, topographic surveys, and explorations and foundation investigations for the Devil Canyon and Watana damsites.

A 52-mile pioneer road from Gold Creek to the Watana damsite would be constructed during preconstruction to allow heavy exploration equipment into the project area to facilitate the preconstruction investigations.

Construction Schedule for the Selected Plan:

General: The construction period for the selected plan is estimated to be 10 years, 6 years for Watana Dam and powerplant, and 5 years for Devil Canyon Dam and powerplant. Construction period for transmission facilities is 3 years. Concurrent construction will be required to meet power-on-line schedules. The following paragraphs describe the sequence of construction for the selected plan's projects.

Diversion Plans: Construction of the diversion works would start in the winter of the first year for Watana and the winter season of the fifth year for Devil Canyon. The diversion works could each be completed in two years.

Main Dams: Site clearing and foundation preparation would start in the third year with material placement scheduled from the fourth into the sixth year of construction for Watana Dam. The diversion tunnel would be closed in spring of the final construction year and Watana reservoir would fill to its normal full pool elevation by fall to supply power-on-line the following winter.

Clearing and foundation preparation for Devil Canyon would start in the seventh year with material placement beginning in the eighth year and continuing into the tenth year of construction. The diversion tunnel would be closed in spring of the tenth year and the reservoir would be filled by fall of the tenth year.

Powerhouses: Construction of underground powerhouses would be concurrent with the main dams of both projects; and excavation and installation of mechanical and electrical equipment would continue year-round. Four generating units would be installed in the Devil Canyon powerplant and three generating units in the Watana powerplant. Power-on-line (POL) for Watana is scheduled for 1986 and Devil Canyon POL is scheduled for 1990.

ECONOMICS OF THE SELECTED PLAN

PROJECT COSTS

The estimated construction cost of the selected plan is $1,520,000,000, which includes $572,000 in non-Federal recreational costs. Adding the $11,800,000 value of public domain transferred without cost gives a total project cost of $1,531,800,000.

Interest during construction is computed as simple interest on project costs from the estimated date of expenditure to the appropriate power-on-line date. The project costs and interest during construction for the Devil Canyon Dam are discounted to the Watana power-on-line date of October 1986.

The investment cost, $1,653,136,000, is the project cost plus interest during construction, both discounted to the 1986 power-on-line date.

Project Cost (Present Worth)	$1,401,295,000
Interest During Construction (PW)	251,841,000
Investment Cost	$1,653,136,000

Amortization of this amount with interest at a rate of 6-1/8 percent and a project economic life of 100 years results in an annual cost of $101,520,000.

The estimated average annual operation and maintenance cost over the 100-year project life of the selected plan is $1,928,000. Annual costs for replacement of mechanical equipment and other items which normally have a useful life less than the 100-year project life are estimated at $572,000. 1/

The following table summarizes the average annual cost for the selected plan:

Interest and Amortization	$101,520,000
Operation and Maintenance	1,928,000
Replacement	572,000
Average Annual Cost	$104,020,000

A detailed cost estimate for the selected plan is contained in Section B, Appendix I.

1/ The O,M&R costs other than those for recreation were provided by Alaska Power Administration.

COST ALLOCATION

Allocation of estimated costs according to the Alternative Justifiable Expenditure method resulted in the following apportionment of joint-use costs:

PURPOSE	PERCENT OF JOINT-USE COSTS
Power	99.69%
Recreation	0.22%
Flood Control	0.09%

The cost allocation results are tabulated below:

COST ALLOCATION ($1,000)

	Power	Recreation	Flood Control	Total
Construction Cost	$1,516,326	$2,912	$762	$1,520,000
Public Domain Cost	11,768	23	9	11,800
Interest During Construction	280,839	587	164	281,590
Operation, Maintenance, and Replacement (Annual Cost)	2,397	102	1	2,500

PROJECT BENEFITS

Benefits accrue to the selected plan from the sale and improved reliability of electric power provided by the project, flood damages prevented, recreational opportunity provided, and Area Redevelopment from the utilization of unemployed labor.

Power: Power benefits are calculated by applying the project capacity and energy to power values derived by the Federal Power Commission and from increased reliability provided by the intertie of the Anchorage-Fairbanks power grids.

Summary of Power Benefits ($1,000)

Capacity	Prime Energy	Secondary Energy	Intertie	Total
93,807	30,883	2,516	947	128,153

Recreation: Recreational benefits are calculated as the use-day value of recreational opportunity provided by the project.

Summary of Recreational Benefits ($1,000) 1/

General	Specialized	Total
110	190	300

1/ Rounded

Flood Control: Flood control benefits are calculated as the value of decreased maintenance of erosion protection to the Alaska Railroad. The benefit totals $50,000 annually.

Area Redevelopment: The Area Redevelopment benefit is calculated as the value of employment provided to un- or underemployed Alaskan labor by project construction. Such employment is estimated as 4,390 man-years giving an average annual benefit of $9,373,000.

Summary of Benefits: Estimated annual benefits are summarized as follows:

Category	Value ($1,000)
Power	128,153
Recreation	300
Flood Control	50
Area Redevelopment	9,373
Total	137,876

PROJECT JUSTIFICATION

The following table summarizes the project economic factors.

Summary of Economic Factors

Item	Recreation	Non-Recreation	Total
Average Annual Benefits	$300,000	$137,576,000	$137,876,000
Annual Costs	165,000	103,855,000	104,020,000
B/C Ratio	1.8	1.3	1.3
Net Annual Benefits	$135,000	$ 33,721,000	$ 33,856,000

The analyses show the project and the incremental recreational development to be justified.

DIVISION OF PLAN RESPONSIBILITIES

The project benefits accrue 93.4 percent to power, 6.3 percent to Area Redevelopment, 0.2 percent to recreation, and 0.1 percent to flood control. All purposes except recreation are solely the responsibility of the Federal Government, while recreation requires participation by a sponsor. In the case of the selected plan, although title to most of the project lands presently rests with the Bureau of Land Management, there is every indication that title will, in the near future, pass to the State of Alaska. Thus, project sponsorship for recreation will also rest with the State.

FEDERAL RESPONSIBILITIES

The United States will design, construct, maintain, and operate the dams, powerplants, roads, and transmission facilities, and will share in the planning, design, and construction of the recreational facilities following Congressional authorization and funding, and after receipt of all required non-Federal contributions and assurances.

The presently estimated Federal share of the total first cost of the project is $1,520,000,000, including an estimated cost of $572,300 for recreation. Annual operation, maintenance, and replacement costs, exclusive of recreation, are $2,400,000.

NON-FEDERAL RESPONSIBILITIES

Non-Federal interests must, prior to the start of construction of recreational facilities, provide to the Secretary of the Army acceptable assurances that they will, in accordance with the Federal Water Project Recreation Act, Public Law 89-72:

a. Administer land and water areas for recreation.

b. Pay, contribute in kind, or repay (which may be through water-use fees) with interest, one-half of the separable costs of the project allocated to recreation.

c. Bear all costs of operation, maintenance, and replacements of lands and facilities for recreation.

PLAN IMPLEMENTATION

The steps necessary to follow in realizing the construction of the proposed plan of improvement are summarized as follows:

Review of this report by higher Corps of Engineers authorities such as North Pacific Division, the Board of Engineers for Rivers and Harbors, and the Office of the Chief of Engineers.

The Chief of Engineers would then seek formal review and comment by the Governor of Alaska and interested Federal agencies.

Following the above State and interagency review, the final report of the Chief of Engineers would be forwarded by the Secretary of the Army to the Congress, subsequent to his seeking the comments of the Office of Management and Budget regarding the relationship of the project to the program of the President.

Congressional authorization of the hydropower project would then be required. This would include appropriate review and hearings by the Public Works Committees.

If the project is authorized, the Chief of Engineers would then include funds, when appropriate, in his budget requests for preconstruction planning of the project.

When Congress appropriates the necessary funds, advanced engineering and design studies will be initiated, project formulation reviewed, and the plan reaffirmed or modified to meet the then current conditions. At this time, assurances of local cooperation will be required from non-Federal interests as appropriate.

Surveys, materials investigations, and preparation of design criteria, plans, specifications, and an engineering estimate of cost would then be accomplished by the District Engineer. At this time, a formal contractual agreement for provision of the necessary local cooperation would be required. The District Engineer would then invite bids and award a contract.

Following completion of certain sections of the project, local interests would be responsible for their operation and maintenance.

It is not possible to accurately estimate a schedule for the above steps because of the variables in the reviewing and funding processes. Once the project is authorized and initially funded, it would be possible to complete design and construction within a 14-year period if adequate funds are available.

VIEWS OF NON-FEDERAL INTERESTS

An active public participation program was maintained throughout the study through public meetings, workshops, informal coordination meetings, and correspondence.

PUBLIC MEETINGS

Preliminary public meetings were held in Fairbanks on 6 May 1974 and Anchorage on 8 May 1974. The meetings were to inform the public of the existence and intent of the study, to assess public views as to their needs and concerns, and to request their input whether it be information, comment, or question. Several environmental groups stated that they would reserve judgment of the project until the Draft Environmental Statement was available for review. Concerns expressed by these groups (the Alaska Center for the Environment and the Sierra Club) included impacts upon the future quality of life in Alaska, which would be caused by hydroelectric development. They also questioned the Alaska Power Administration's projection of power needs, the examination of alternatives, and the shipping of Alaska's fossil fuels elsewhere. They stressed the need for coordination with the Alaska Land Use Planning Commission, and suggested public hearings on the Final Environmental Impact Statement.

Intermediate public meetings were held at Anchorage on 27 May 1975 and at Fairbanks on 29 May 1975. A public brochure outlining the study progress; alternatives developed; and preliminary data on the dimensions, outputs, and environmental effects of the alternatives, was distributed. The meeting resulted in general expression of the preferability of hydropower to fossil fuel alternatives. Environmental groups represented included the Alaska Conservation Society, the Sierra Club, and the Alaska Center for the Environment. Comments of these groups included the opinion that the project would spur more growth, but that nuclear energy was believed not to be an acceptable energy source at this time. They further recommended the alternative of burning solid wastes to produce power. They were troubled by the location of transmission lines, and stated that we may have a greater need for hydroelectric power in 50-75 years. They questioned hydroelectric power as being a renewable resource. Other concerns included land status of the affected areas, siltation, costs of power, and the need for considering alternative sources of power. Assurances were given that such effects and many others were under study and would be given careful consideration in design and construction of any recommended project.

Late stage public meetings were held at Anchorage on 7 October 1975 and at Fairbanks on 8 October 1975 to present the study findings and the District Engineer's tentative conclusions and recommendations. A number of environmental groups were represented at one or both of these meetings. They included: the Isaac Walton League, the Mountaineering Club of Alaska, the Alaska Conservation Society, Knik Kanoers and Kayakers, and Fairbanks Environmental Center. Comments included the need for Corps funding for fish and wildlife studies and data processing of environmental information. Expressed concerns included the inundation of a scenic, whitewater river, location of the project area too close to a proposed Talkeetna State Park, too much human use in the area, impacts on moose habitat and downstream salmon runs, differences reflected in the 1960 and 1975 cost estimates, the low interest rate used in computing project benefits, who would operate the dams and sell the power, reservoir siltation, turbidity, fluctuations in streamflows, impacts on permafrost, the possibility of earthquakes, the formation of frazil ice, the geology of the area, benefits claimed for flood control, the location of transmission corridors and construction of transmission lines, land status, impacts upon population growth, recreational development, the production of secondary energy, and others. Most of these groups voiced either strong opposition to the project or reserved judgment pending further studies and specific project recommendations.

Many organizations, groups, and individuals expressed support of the selected plan. An informal poll of people attending the late stage public meetings indicated about five persons favoring to each person opposing the project.

WORKSHOPS

Workshop meetings were arranged and held with the following interested groups:

30 April 1974 with environmental organizations

29 October 1974 with Federal and State agencies

13 March 1975 with the Cook Inlet and AHTNA regional native corporations.

INFORMAL MEETINGS

Informal meetings at the field level were held throughout the study with participating and interested Federal and State agencies on topics including but not limited to technical, environmental, archaeological and historical, economic, and recreational aspects of the study.

CORRESPONDENCE

Appendix 2 contains a representative display of correspondence from non-Federal agencies, groups, and individuals. Included specifically is a letter from the State of Alaska, Division of Parks, expressing willingness to participate in the cooperative planning and development of recreation for the project.

The concurring comments of the State of Alaska, Department of Fish and Game, are included in report of the United States, Fish and Wildlife Service project report which is reproduced in Appendix 2.

REVIEW BY OTHER FEDERAL AGENCIES

The study of the Upper Susitna River Basin project has been reviewed by the following Federal agencies having responsibilities related to water resource development:

U.S. FISH AND WILDLIFE SERVICE

In accordance with the Fish and Wildlife Coordination Act, 48 Stat. 401, as amended: 16 U.S.C. 661 et. seq., and the National Environmental Policy Act of 1969 (P.L. 90-190; 83 Stat. 652-856), the U.S. Fish and Wildlife Service has reviewed the project proposal and has prepared a report recommending:

1. The project be designed, constructed, and operated in such a manner as to provide water releases or a flow regime below Watana and Devil Canyon Dams of suitable temperature and water quality, to preserve existing downstream fish resources. Sufficient detailed hydraulic and biological information is not available at this time to determine the above requirements. Should the flow requirements and water quality needed to preserve the existing downstream fish resources not be obtainable or that the fish resources are lost as a result of the project construction or operation, artificial propagation facilities will be required at project cost. In the event that adequate natural reproduction fails to occur in the tributary streams to the reservoir areas, a stocking program will be required at project expense. Costs of appropriate studies, design, construction, operation, and maintenance of the facilities should be authorized as a project cost. The design and location of the artificial propagation facilities should be developed cooperatively with the Fish and Wildlife Service, Alaska Department of Fish and Game, National Marine Fisheries Service, and the Corps of Engineers. The facility would be operated by the Alaska Department of Fish and Game.

2. If fluctuations of discharge flows below Watana and Devil Canyon Dams create a public hazard or are detrimental to the maintenance of downstream fish resources, a regulating dam and reservoir will be required.

3. Provide safe and convenient access for fishermen to project facilities for recreational purposes.

4. The report of the District Engineer include the preservation, propagation, and management of fish and wildlife resources among the purposes for which the project will be authorized.

5. Project lands be acquired in accordance with Joint Army-Interior Land Acquisition Policy for Water Resource Projects.

6. Leases of Federal land in the project areas reserve the right of free public access for hunting and fishing.

7. All project lands and waters at the Devil Canyon and Watana reservoirs which are not designated for recreation, safety, and efficient operation be dedicated to use for fish and wildlife management, in accordance with the provisions of a General Plan prepared pursuant to Section 3 of the Fish and Wildlife Coordination Act. These lands and waters should be made available to the Alaska Department of Fish and Game for management.

8. Detailed biological studies of fish and wildlife resources affected by the project be conducted jointly during pre- and post-authorization periods by the U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, National Marine Fisheries Service, and the Corps of Engineers. These studies shall be allocated as a joint cost among project purposes.

9. The U.S. Fish and Wildlife Service and the Alaska Department of Fish and Game investigate portions of the Upper Susitna River Basin and other areas as replacement habitat for losses caused by the proposed project. The areas delineated should be covered by a General Plan prepared pursuant to Section 3 of the Fish and Wildlife Coordination Act. Operation, maintenance, and replacement costs shall be authorized as a project cost.

10. A reservoir clearing plan and a reservoir recreational zoning plan be developed, as necessary, to insure that certain areas, or certain periods, are available for fishing, hunting, and other fish and wildlife purposes without conflicting uses. These plans shall be developed cooperatively by the U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, Corps of Engineers, and Bureau of Outdoor Recreation.

11. To produce the least potential adverse impact on raptors, the transmission lines should be placed along the west side of the Parks Highway.

12. Section of road right-of-ways, borrow areas, and related construction operations be planned in cooperation with the U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, Bureau of Outdoor Recreation, and the Corps of Engineers, so as to minimize damage to fish and wildlife and other recreational resources.

The foregoing recommendations have been carefully considered and are commented on by corresponding numbers as follows:

1. This recommendation is generally in accord with Corps policy as it concerns existing fishery resources. Specific mitigation measures cannot be addressed until post-authorization, preconstruction studies have affirmed and defined the need, types, and extend of measures most appropriate. Stocking of the reservoirs in the interest of promoting a new fishery is considered a function of the fishery management agencies unless it is determined that this is a mitigation measure which should be accomplished at project cost as a consequence of fishery losses caused by the project. Continued coordination with all responsible agencies is consistent with Corps policy and practice.

2. The Corps believes that all means of preventing a public hazard or conditions detrimental to the maintenance of downstream fishery resources should be considered. A reregulating dam would be one of these considerations.

3. The plan of improvement includes recreation as a project purpose and provides facilities to promote that end.

4. Provisions of the Fish and Wildlife Coordination Act and existing inter-agency agreements will be closely adhered to concerning determinations relevant to preservation, propagation, and management of fish and wildlife resources.

5. Project lands will be acquired in accordance with all applicable statutes and policies.

6. There is no objection to recommendation 6 to the extent it is consistent with recommendation 7.

7. Recommendation 7 is in accord with Corps policy and consistent with existing Corps practice.

8. The Corps concurs in the need for pre-impoundment studies of fish and wildlife resources. No further funding of project-related studies is likely to be provided by the Congress prior to authorization for preconstruction planning. During the preconstruction planning period, the Corps will consider and recommend financing of studies on the basis of detailed proposals submitted by Fish and Wildlife Service at that time. Such studies shall be allocated as a joint project cost.

9. The Corps concurs with the intent of this recommendation, but feels that studies of mitigation measures should await such time as the biological studies contained in recommendation 8 indicate the need, type, and extent of such mitigation.

10. The development of clearing and zoning plans are standard Corps practice. Every effort will be made to coordinate such planning with all interested agencies.

11. Careful consideration will be given to avoidance of adverse effects on raptors as one of the factors affecting siting of the transmission facilities.

12. This recommendation is in accord with Corps policy and practice.

NATIONAL MARINE FISHERIES SERVICE

National Marine Fisheries Service concurs in the recommendations of the Fish and Wildlife Service report by indorsement contained therein.

BUREAU OF LAND MANAGEMENT

Bureau Land Management found that predicting possible project effects on BLM land was not possible inasmuch as the near future ownership of those lands at the project are undergoing rapid change. They recommended that access points to the lakes be kept in public ownership. BLM also expressed interest in cooperative recreational development should the lands remain under their jurisdiction.

ALASKA POWER ADMINISTRATION

Coordination with APA has been close and continuous since inception of this study. In accordance with statutes, regulations, policy, and/or at the request of the District Engineer, APA conducted studies and prepared analyses of power marketability and transmission systems, including an environmental assessment of the latter. The District Engineer has reviewed these analyses and has adopted them for inclusion as appropriate portions of the Corps of Engineers report. APA has reviewed the Corps of Engineers report, and generally concurs with it, with the exception that they believe that the Denali unit may, in the future, be a desirable addition to the system. APA finds the proposed plan to be feasible from the viewpoint of power marketability.

OTHER FEDERAL AGENCIES

A number of other Federal agencies provided comments in response to their review of the Environmental Impact Statement. These comments generally expressed concern for a need of more detailed studies related to the project and its probable impacts prior to construction.

Letters from the contributing agencies are contained in Appendix 2.

SUMMARY

This report considers the desirability of providing power to the Southcentral Railbelt area of Alaska by the development of the hydroelectric power potential of the Susitna River. Previous studies by both the Corps of Engineers and the United States Bureau of Reclamation have shown that the Upper Susitna River Basin, above the confluence of the Susitna and Chulitna Rivers provides the great majority of the total river potential. Accordingly, the report concentrates on that basin.

The Southcentral Railbelt comprises the lands along and convenient to the Alaska Railroad, including the two largest cities of the State, Anchorage and Fairbanks; the major potential agricultural areas of the State, the Matanuska and Tanana Valleys; and the Kenai Peninsula. The economy of the region is varied. Government, trade, services, construction, transportation, mineral extraction (especially oil and gas), and manufacturing (mostly seafood processing) are the main employers. A well-developed system of highways links the population centers as, to a lesser degree, does the Alaska Railroad. Both Anchorage and Fairbanks are served by international air carriers and are centers for distributary interstate air service.

The Railbelt contains almost three-fourths of the population of the State, 245,000 out of 330,000 as of 1973. The population is expanding at the rate of three percent per year, mostly by natural increase, but with about one-fifth by immigration. This rate is expected to continue for many years to come. With the population increase and expansion of economic activities, the growth in power demand has been at a rate of 14 percent annually for the past decade. The present demand, 2.03 billion kilowatt-hours annually, comprised of 80 percent utility, 19 percent national defense, and 1 percent industrial, is projected to grow but at a steadily decreasing rate, being on the order of 6 percent by the year 2000. The industrial share is projected to increase to 20 percent by 2000, while the national defense and utility shares are projected to decrease to 3 percent and 77 percent respectively. Total demand is projected to be 7.6 billion kilowatt-hours annually in 1990 and 15 billion kilowatt-hours annually in 2000.

In the interest of multi-objective planning, other needs (water resource development) of the Railbelt area were examined. Needs identified which could reasonably be addressed in conjunction with the directed study power objective include flood control, recreation, conservation, and enhancement of fish and wildlife resources, air quality, conservation of nonrenewable resources, and national energy independence. In furtherance of the multi-objective goals, studies in connection with the report have been coordinated with other Federal and State agencies concerned with various phases of water and related land resource development

A broad range of alternative means of accomplishing the primary study objective were examined for technical, economic, and environmental feasibility. Included were both conventional power producing systems based on coal, oil, gas, nuclear energy, and hydroelectric energy, and less conventional systems based on wind, tides, solar energy, solid wastes, wood, and geothermal energy. Coal and hydroelectric energy were found to be both feasible. An in-depth evaluation of these alternatives was then made giving equal consideration to economic and environmental aspects of their performance.

Each alternative was found to have satisfactory economic performance and each was found to have a range of unavoidable adverse effects on the environment, mainly on fish and wildlife, and esthetic values.

A plan of improvement selected as the most feasible for water and related land resource development consists of two dams with reservoirs, powerplants, and operating facilities located on the upper Susitna River at the Devil Canyon and Watana damsites, and of a transmission system from the development sites to Anchorage and Fairbanks. This selected plan is considered the most favorable with the maximum of net benefits, the least unavoidable adverse environmental impacts, and the greatest response to the multiple study objectives.

STATEMENT OF FINDINGS

The District Engineer reviewed and evaluated, in light of the overall public interest, the documents concerning the proposed action, as well as the stated views of other interested agencies and the concerned public. The review and evaluation of alternatives have been in accordance with a resolution of the Committee on Public Works of the U.S. Senate, adopted on 18 January 1972, directing that a study be made "... with particular reference to the Susitna River hydroelectric power development system, including the Devil Canyon Project and any competitive alternatives thereto, for the provision of power to the Southcentral Railbelt Area of Alaska."

The possible consequences of these alternatives have been studied for environmental, social well-being, and economic effects, and for engineering feasibility. The alternatives were assessed and evaluated in light of national objectives related to regional and national economic development, and preservation and enhancement of environmental quality, in accordance with the Water Resources Council's Principles and Standards for water and related land resources planning.

In evaluation of the selected plan and other alternatives, the following points were considered pertinent:

PLAN SELECTION CRITERIA

A basic premise utilized in the assessment and evaluation of alternative electrical generating facilities is that growth in electrical power demand will be as projected by the Alaska Power Administration. Their projected growth rates after 1980 are substantially below existing trends and they also reflect an assumed substantial savings through increased efficiency in use of energy and implementation of electrical energy conservation programs; thus, they are judged to be conservative. Another assumption is that required electrical power generation development from whatever source or sources will proceed to satisfy the projected needs. Also considered in the weighing of alternatives is that a plan must be technically feasible at the present time to be considered for initial development. After considering numerous alternative sources of power, those adjudged to be most competitive to hydropower were coal and gas, or oil thermal generating facilities. The choice of the selected plan is based on the identification and evaluation of significant environmental, social, and economic effects associated with these and other alternatives, including that of no Corps action. These factors, plus engineering feasibility, were considered in arriving at the selected plan in preference to other alternatives. A final consideration in the choice of the selected plan is Public Law 93-577, passed by Congress on

31 December 1974, which establishes as national policy the conservation of nonrenewable resources through the utilization of renewable resources, where possible.

ENVIRONMENTAL CONSIDERATIONS

All viable alternatives (those having existing technical feasibility, which provide a long-term source of power, and which would provide amounts of electrical energy approximately equivalent to the selected plan) would have some adverse impacts on the total human environment. Although adverse impacts related to coal would be of a different nature than those caused by hydropower, they would be significant, and in some respects, would be less amenable to amelioration or mitigative efforts. However, the selection of a hydropower alternative does not preclude the possibility, or likelihood, that coal will be mined and utilized for exportation or as a supplemental source of power within the Railbelt area itself. Gas or oil would have less overall adverse environmental impact than coal and hydropower. However, long-range outlooks for availability and costs of oil and gas, and the possibility that higher and better future uses can and probably will be made of these resources, makes them economically and socially less desirable than coal or hydropower. The oil and gas alternative was rejected largely on the basis of the national efforts to develop energy sources that limit the use of oil and gas for power generation. Significant impacts directly related to the selected plan include inundation of some 50,550 acres of land and 82 miles of natural stream (including 9 miles of a unique 11-mile reach of whitewater rapids) and associated wildlife and fishery habitat, creation of reservoirs perpendicular to caribou migration routes which lead between calving grounds and winter ranges, and changes in downstream flow regime and water quality characteristics. The selected plan is determined to be environmentally acceptable in that it provides, from all the viable alternatives, the most favorable balance in the tradeoffs between resources irretrievably lost and long-term benefits derived.

SOCIAL WELL-BEING CONSIDERATIONS

A major consideration was the fulfillment of projected energy needs of a moderately growing population in the Southcentral Railbelt area. Reliability and long-term benefits were considered to be essential to any plan of development. These conditions are more assured with coal and hydropower than they are with gas and oil. Without an intertie, a coal alternative would be less reliable. Conservation of nonrenewable resources was also viewed as a growing social concern. No other alternative considered would likely have less direct impact on existing manmade resources or developments than the selected plan. The remote, essentially uninhabitated project site and the lack of developed private property precludes the social disruption associated with displacement of people's homes, businesses, and institutions. Adverse social effects resulting from the plan include drastic modification of the existing natural visual quality of the area, physical disturbance of an essentially wilderness setting, changes in traditional recreational usage of the project area and surrounding lands, and influx of temporary construction workers on small communities near the construction sites.

ECONOMIC CONSIDERATIONS

From an economic standpoint, the selected plan is estimated to provide the greatest net addition to national economic development of all alternatives studied. Additionally, the regional economy will be benefited through the employment of a significant number of otherwise unemployed individuals.

ENGINEERING CONSIDERATIONS

All major alternatives considered are technically feasible, involving only existing technology, methods, and equipment to construct and operate. Of the hydroelectric alternatives, the selected plan utilizes the two damsites with the most favorable foundation conditions. Both dams are large, the Watana structure exceeding the height of the highest present earthfill structure in the Western Hemisphere. Major considerations in the design of the structures include the possible effects of high intensity earthquakes because the project site is in a zone of high seismic activity, outlet works to allow rapid and safe draining of the impoundments if, in spite of all design efforts, one or both of the structures is severely damaged to the point of imminent failure, and multiple-level intake works providing for selective withdrawal of waters to allow control of downstream water quality in the interest of conserving or enhancing downstream fishery values.

OTHER PUBLIC INTEREST CONSIDERATIONS

Close coordination has been maintained with other agencies, groups, and the general public throughout the study period. Results of a series of public meetings indicate general public support for the selected plan. However, vocal opposition in response to public review of the Draft Environmental Impact Statement has been expressed by some environmental groups and individuals. Notable among these are the Sierra Club, the Upper Cook Inlet and College Chapters of the Alaska Conservation Society, Knik Kanoers and Kayakers, Inc., and individual whitewater boating enthusiasts. Several Federal agencies, particularly the Bureau of Land Management, the U.S. Geological Survey, and the U.S. Fish and Wildlife Service have expressed views concerning the need for detailed environmental and geological studies prior to final determinations regarding project construction.

The action proposed, as developed in this report, and in accordance with the Principles and Standards established by the Water Resource Council, is based on a thorough analysis and evaluation of various practicable alternatives which would achieve the stated objectives.

Wherever adverse effects are found to be involved which cannot be avoided by following reasonable alternative courses of action to achieve the congressionally specified purpose, they can either be ameliorated or are substantially outweighed by other considerations of national policy. The recommended action is consonant with national policy, statutes, and administrative directives. It is concluded that, on balance, the total public interest should best be served by implementation of the recommendations of this report.

DISCUSSION

LOAD GROWTH PROJECTIONS

Load growth projections as provided by Alaska Power Administration for the period 1974 through the year 2000 covered a range of power requirements, high, mid-range and low. Feasibility report utilized the mid-range projection which has been endorsed by both Alaska Power Administration and Federal Power Commission. Substantial amounts of new generating capacity will be needed to meet future power requirements of the Southcentral Railbelt area. Recent studies of the Southcentral and Yukon region (which includes the Southcentral Railbelt as its main component), as defined in the 1974 Alaska Power Survey Report of the Executive Advisory Committee, indicate that rapid rates of increase in power requirements will continue at least for the balance of the 1970's, reflecting economic activity associated with North Slope oil development and expansion of commercial and public services. Estimates beyond 1980 reflect a range of assumptions as to the extent of future resources use and industrial and population growth. All indications are that accelerated growth will continue through the year 2000, with economic activity generated by North Slope oil and natural gas development being a major factor - but only one of several important factors. It is generally considered that the Southcentral-Yukon regional population will continue to grow at a faster rate than the national and State averages, that future additional energy systems and other potential mineral developments will have a major effect, and that there will be notable expansion in transportation systems. Significant economic advances for all of Alaska and especially for the Alaska native people should be anticipated as a result of the Alaska Native Claims Settlement Act. Other influencing factors could be cited, but the general outlook is for further rapid expansion of energy and power requirements in the Southcentral-Yukon area. A range of estimates for future power requirements of the Southcentral and Yukon regions is presented in the 1974 Report of the Alaska Power Survey Technical Advisory Committee on Economic Analysis and Load Projections. The range of estimates attempts to balance a myriad of controlling factors including costs, conservation technologies, available energy sources and types of Alaskan development. The higher growth range anticipates significant new energy and mineral developments from among those that appear more promising. The lower growth range generally assumes an unqualified slackening of the pace of development following completion of the Alyeska pipeline and is not considered realistic. The mid-range growth rate appears to be a reasonable estimate which we adopt as most representative based on recent manifestations and assessment of future conditions. It should be noted that there are several responsible advisory committee members who feel that recent acceleration of mineral raw material shortages of all kinds indicates a possibility that even the high range estimates could be exceeded.

ALTERNATIVE ENERGY SOURCES

Alternative energy sources for electric power generation include fossil fuels, oil, natural gas and coal and nuclear power. Alaska has large known and potential reserves of fossil fuels. Alaska power systems now depend on oil and gas for about 60 percent of total energy production. The predominant energy source for Anchorage is presently natural gas and for Fairbanks service area, coal and oil.

The Federal Power Commission has provided at-market power values for the Anchorage and Fairbanks market areas at 1975 price levels. The at-market power values for the Fairbanks area are based on estimated costs of power from an alternative coal-fired generating plant with 150 MW total capacity consisting of two 75 MW units; heat rate, 12,000 btu/kwh; capital cost, $640 per kilowatt; service life, 35 years; and coal cost of 60¢ per million btu. For the Anchorage area, the at-market power values are based on estimated costs of power from two alternative sources, coal fired and combined cycle. The combined cycle power values are based on a plant with 450 MW total capacity and natural gas operating cost of 70¢ per million btu. The coal fired power values are based on a plant with 450 MW total capacity and coal cost of 50¢ per million btu.

Due to the uncertainty of the future availability of natural gas after 1985 for new generating capacity, the unforeseen possibility of its restrictive use if available, and its sensitivity to worldwide economic pressures, coal is considered to be the most likely alternative fuel for thermal-electric plants to be constructed in the Anchorage service area after 1985.

The present day price of 70¢ per million btu paid for natural gas used by the Anchorage utilities is not a realistic basis for selecting the most likely source of fuel for future thermal electrical generation after 1985. The current price does not reflect true economic value because of the existence of regulated markets. Also, the source of gas presently supplying Anchorage needs will, because of limited reserves, increasing local needs, and national and international competition for supplies, not be available in the post 1986 time frame. If gas is to continue to be utilized for power generation in the Anchorage area, Prudhoe Bay or equally costly sources will have to be tapped. The value of North Slope gas in Anchorage under reasonable assumptions regarding transportation systems is approximately $1.46 per million btu. This value of gas would result in a comparable cost for the combined cycle and coal-fired alternatives.

The extensive coal deposits near Cook Inlet are attractive future alternative sources of energy for this region and could lead to options to convert from oil and natural gas to coal as the major power source during the 1980's. Coal reserves in the Beluga River area north and west of Anchorage contain an estimated 2.3 billion tons, or the equivalent of almost 6 billion barrels of oil. Coal resources in the Nenana field south of Fairbanks near Healy contain an estimated 7 billion tons.

In summary, coal is the least costly alternative to hydroelectric power in the Fairbanks area and in the mid-1980 time frame, natural gas and coal in the Anchorage area are comparable as the most economical alternative. Recognizing the uncertainty of the future availability of natural gas and oil after 1985 for new generating capacity, the possibility of its restrictive use if available and its sensitivity to worldwide demand and economic pressures, coal is considered the most likely alternative fuel for thermal-electric plants to be constructed in the mid-1980's and beyond for the Anchorage area.

FORMULATION

A number of alternative plans were studied in the process of developing the most feasible project for developing the hydroelectric potential of the upper Susitna River Basin. The most favorable of all the plans investigated is a combination of two dams, Devil Canyon, located at river mile 134 with normal pool elevation of 1450, and Watana, located at river mile 165, 31 miles upstream of the Devil Canyon site, with a normal pool elevation of 2200. The selected two-dam system would provide 6.1 billion kilowatt-hours of firm electrical power annually from a dependable capacity of 1394 megawatts, or nearly 96 percent of the basin potential.

The two dams were analyzed separately and together as a coordinated system for maximum development of the hydroelectric potential of the basin. As a single unit, Watana could develop 3.1 billion kilowatt-hours of firm power annually and Devil Canyon, as an independent unit, 0.9 billion kilowatt-hours of firm annual energy. As a system, the two dams would provide 6.1 billion kilowatt-hours of firm power annually because of the value of Watana storage in providing flow releases to increase Devil Canyon power production. An analysis was also made to identify the best sequence of construction. It was found that Watana, first added, that is Watana constructed first with power on line date of 1986 and Devil Canyon last added with power on line date of 1990, was the best sequence. Benefit-to-cost ratio for Watana, first added, is 1.28 while Devil Canyon, first added, results in a benefit-to-cost ratio of 0.80. The combination of the two dams, with either Watana or Devil Canyon constructed first, would not materially change the benefit-to-cost ratio of 1.3 for the total project.

The multiple-purpose projects, while providing for the projected power needs for the Railbelt Area, would also provide flood damage reduction downstream of Devil Canyon and for recreational opportunities associated with the two reservoirs. Construction of the project would also provide employment opportunities for better utilization of underutilized and unemployed labor.

The selected combination of Watana-Devil Canyon provides the most efficient national economic development (NED) plan with a maximum of net benefits exceeding $33.8 million annually. The selected plan also makes a positive contribution toward the environmental quality (EQ) of the study area. Development of the hydroelectric potential of the Susitna River Basin would conserve over 5.8 million tons of coal annually or 15 million barrels of oil annually. Positive contributions to improvements in air and water quality would result from reduction in coal-fired plants and reduction in the mining of coal.

A transmission intertie between the major load centers of Anchorage and Fairbanks would provide an increased reliability and would allow transfer of energy between the load centers with greater flexibility of operation. The transmission system would consist of two single circuit 345 KV lines a distance of 136 miles to Anchorage and two single circuit 230 KV lines a distance of 198 miles to Fairbanks. Value of the transmission intertie has been estimated and included in the economic feasibility analysis for the project.

The Watana and Devil Canyon dam sites are located some 50 miles from existing roads and the only access presently is by helicopter. Early construction of an access road would facilitate preconstruction planning activities for mapping and foundation explorations, with a reduction in total project costs as compared to access by helicopter. In scheduling the construction activities to meet the expedited power-on-line date of 1986, it was also found that early construction of the access road was essential to mobilize the men, equipment and supplies necessary for construction of a project of this magnitude. For these reasons, the access road should be constructed during the initial phase of preconstruction planning rather than incur a delay of at least one year in meeting initial power-on-line date of 1986. In addition to the savings that would be incurred in mobilizing men and equipment during the early phases of the operation, early construction of the access road would provide an additional year of power revenue estimated at approximately $115 million. Construction of the access road at an estimated cost of $22.3 million is well justified.

FEASIBILITY OF ADDITIONAL UNITS

Studies have indicated the need and feasibility of providing hydropower from the Susitna River projects to meet the railbelt area's future load growth from a projected power-on-line date of 1986 through 1996 when the projects full power capability would be utilized. After 1996, the system would require additional generating capacity; hydropower, fossil fuel, or nuclear thermal generation.

Past studies by a number of agencies have indicated substantial hydropower potential available for development to meet load requirements well beyond the year 2000. The State of Alaska has a hydropower potential of over 27 million kilowatts. Generally, as the availability of fossil fuels becomes increasingly scarce and more valuable over time, the alternative renewable hydropower resource will continue to provide the most economical means for meeting the railbelt area's power needs beyond the year 2000. The feasibility of adding units at Watana and Devil Canyon for system peaking requirements in conjunction with thermal base energy was analyzed, in the event more expensive thermal base energy was added to the system in the post 2000 period. For this analysis it was assumed that the baseload thermal plants would operate at 50 percent plant factor the first year and 65 percent thereafter; also, the pre-Susitna thermal generation facilities would be retired after their 30 year economic life, with the last units retiring in year 2015. A load resource analysis determined that the additional units would be needed as follows:

Watana #4	2003
Watana #5	2005
Devil Canyon #5	2008
Devil Canyon #6	2010

Costs were estimated for construction of skeleton bays during initial powerhouse construction, including penstocks and tailrace excavation. Incremental costs at Watana for two skeleton bays are estimated at $67,560,000 (1984-85) and $45 million per unit in years 2002 and 2004, for a total of $157,560,000. Incremental costs at Devil Canyon for two skeleton bays are estimated at $32,240,000 (1990-91) and $40 million per unit in years 2007 and 2009, for a total of $112,240,000. Total costs for the four added units are estimated at $270 million. These costs do not include a reregulating dam downstream of Devil Canyon with an estimated cost in excess of $100 million. The reregulating dam would probably be required if additional units were added at Devil Canyon.

Estimated average annual costs and benefits are as follows:

($1000)	Watana	Devil Canyon
Annual costs	6950	3750
Annual benefits	7470	4110
BCR	1.07	1.10
Comparability ratio	0.98	1.0

As can be seen, even under the most optimistic of assumptions, added units at Watana cannot pass the comparability test; units at Devil Canyon are marginal; however, with the added costs of a reregulating dam, added units at Devil Canyon would also not be justified.

ENVIRONMENTAL CONSIDERATIONS

The Susitna River, with an overall drainage area of about 19,400 square miles, is the largest stream discharging into Cook Inlet and is an important access route to upper river and tributary spawning and rearing areas for the five species of Pacific Salmon found as adults in the inlet. Portage Creek, three miles below the Devil Canyon damsite, is the uppermost tributary on the Susitna River where significant numbers of spawning salmon have been noted. Investigations conducted by the Fish and Wildlife Service intermittently from 1952 to 1975 failed to reveal the presence of adult or juvenile salmon in the Susitna River above the proposed Devil Canyon damsite. No actual waterfalls or physical barriers have been observed in or above the Devil Canyon area which would preclude salmon from utilizing the Susitna River drainage area above the damsite. The most logical reason for the absence of salmon is the presence of a hydraulic block resulting from high water velocities for several river miles within Devil Canyon.

Twenty-seven spring fed slough areas adjacent to the main stream Susitna River between the Devil Canyon damsite and downstream to the confluence with the Chulitna and Talkeetna Rivers, a distance of approximately 60 miles, have recently been identified as being important for fish rearing. Adult spawning salmon have been recorded in 9 of the 27 sloughs. Rearing salmon fry have been observed in 17 of the sloughs. Additional slough areas are probably present in the same reach or further downstream. However, those slough areas downstream of Devil Canyon would not be appreciably influenced by flow releases with normal daily fluctuation of less than one foot or under rare, extreme conditions of up to three feet at Gold Creek, 15 miles below Devil Canyon. In addition, any change in turbidity as a result of the project would not be evident below the confluence of the Chulitna and Talkeetna Rivers.

Regulated flow vs. natural flow data should be obtained in the important slough areas to determine whether remedial measures would be necessary to prevent dewatering of the sloughs during spawning and incubation times. Reduction in flows and turbidity in the summer months may have a minor impact on adult fish orientation. However, these impacts should be negligible after the first five years after construction as juveniles that have been exposed to the changed flow and turbidity regimen would be returning as adults. Reduced turbidities in the summer months could be beneficial for fish production and for sport fishery. Increased turbidities are forecasted to occur during the winter months; however, the amount expected to occur would be below a level that would adversely impact fish. Selective withdrawal structures will be incorporated in the proposed project to permit the release of water that has been mixed to approach natural temperature conditions. Dissolved gas supersaturation that might occur when spilling would be substantially reduced in the turbulent river section that would be present just downstream of the Devil Canyon Dam. Upstream from the dams, the major impact on the resident fish populations would be caused by the reservoir impoundments. Under the proposed plan, Devil Canyon Reservoir would fluctuate very little. Even though the steep-walled canyon of this reservoir might prove less than desirable for a program to develop a resident fish population, some species of fish might be able to adapt to this reservoir and provide some future sport fishing benefits.

Watana Dam would have a wide range of drawdown in the reservoir which although not impacting the fishery resource would make access more difficult, resulting in lower fishing pressure. Suspended glacial sediment could be a factor in both of the reservoirs after the heavier glacial sediments have settled out; however, many natural lakes in Alaska such as Tustumena and Tazlina, with heavy inflows of glacial debris sustain fish populations under similar conditions, so to develop populations of fish under related conditions should prove feasible. Most resident fish populations, especially grayling, utilize some of the clearwater tributaries of the Susitna River or areas near the mouths of these streams as they enter the glacially turbid main river channel during periods of high runoff. Many of these tributaries would be flooded in their lower reaches by the proposed reservoir impoundments. The resident fish populations would be affected by the increased water levels in the proposed reservoirs; but in some areas, access to tributaries for resident fish may be improved by increased water elevations.

Impacts on wildlife would occur primarily in the Watana Reservoir portion of the Susitna River. The area downstream of the Watana Dam is a narrow steep-walled canyon with few areas of big game habitat and is not crossed by any major migration route for big game. The upper section of the Watana Reservoir would lie across one the Netchina caribou use as an intermittent seasonal migration route between their main calving area and their summer range. The reservoir could conceivably alter historical herd movement and distribution and prior to ice break-up mortalities could occur because of ice-shelving. Moose habitat would be lost upstream of Watana Dam. Data on the number of acres of good habitat impacted and the number of animals using the areas are preliminary. Additional data are needed on both the moose and caribou herds before a determination can be made for the need for compensation measures.

Transmission corridors required to distribute the electric power that would be generated by the proposed project would total about 364 miles. The corridor to Fairbanks is identified as the Nenana Corridor and the one to Anchorage the Susitna Corridor. These corridors would require approximately 8,200 acres, of which 6,100 acres would have to be cleared. Aquatic impacts would occur primarily during the clearing for and the construction of the actual transmission facilities and would be of a temporary nature. Some erosion, causing turbid condition in streams crossed by the corridors, could occur on cleared land after construction, but is expected to be minor. Impacts on caribou would be limited to the 136 mile segment of the Nenana Corridor north of Cantwell since there is no significant caribou use of areas to the south. Although physical destruction of caribou habitat will not be a significant impact, indirect consequences such as man-caused fires, noise generated by transmission lines and increased human access could be significant. Moose are found throughout the length of the transmission line corridor. The greatest impact to these animals would be the increased hunting access provided by roads and the openness of the corridor itself. Habitat would overall be improved. Subclimax growth within the transmission line corridor would increase moose browse. A transmission line, per se, will not have many lasting impacts upon wildlife; most of the impacts will be a result of construction and maintenance.

CONCLUSIONS

On the basis of data and studies presented in this report, it is concluded that:

a. Power needs in the Railbelt Area of Alaska are estimated to more than double by 1985 from the present 2 billion kilowatt-hours to 5.5 billion kilowatt-hours and 15 billion kilowatt-hours by the year 2000. These values represent the mid-range growth projections of the three ranges of projections prepared by Alaska Power Administration, the Federal marketing agent for electrical energy in Alaska.

b. The formulated plan would meet the need for increased supplies of electrical energy while conserving non-renewable fossil fuels. oil, natural gas and coal. Coal is the least costly alternative to hydroelectric power in the Fairbanks area and in the mid-1980 time frame, natural gas and coal are comparable as the most economical alternative in the Anchorage area. Recognizing the uncertainty of the future availability of natural gas and oil after 1985 for new generating capacity, the possibility of its restrictive use if available and its sensitivity to world-wide demand and economic pressures, coal is the most likely alternative fuel for thermal-electric plants to be constructed during the project life for the Anchorage area.

c. Of the alternative plans analyzed, the best plan is a combination of two dams, Devil Canyon, located at river mile 134 with normal pool elevation of 1450, and Watana, located at river mile 165 with a normal pool elevation of 2200.

d. The best sequence of construction would be Watana first added with Devil Canyon second. The two dams acting together would provide 6.1 billion kilowatt-hours of firm power annually. Watana reservoir's 6.5 million acre-feet of usable storage provides the required flow releases for dependable power production at Watana and Devil Canyon.

e. Under normal load requirements, the Watana project would be operated to meet peaking requirements with Devil Canyon operating at a more uniform rate in the base load. Watana and Devil Canyon reservoirs would fluctuate only slightly in response to daily load requirements and daily fluctuations in river stage downstream of Devil Canyon would be less than one foot. Under extremely rare adverse load conditions, downstream river fluctuations could be as much as three feet at Gold Creek, 15 miles below Devil Canyon. Because Devil Canyon would be operating essentially as a reregulating dam to control the rate of downstream flow releases, a reregulating structure downstream of Devil Canyon is not required.

f. The future addition of units at Watana and Devil Canyon, based on 1975 price levels and projected power demand beyond the year 2000, is not economically feasible at this time. However, during preconstruction planning for the project, the feasibility of adding units would be reanalyzed.

g. Reservoir storage on the Susitna River will permit multiple use of the water resource through hydropower generation, flood control and recreation. Total annual benefits exceed total annual costs by $33.8 million. The benefit-to-cost ratio is 1.3 and the comparability ratio for power is 1.2. Costs allocated to power would be repaid over a 50-year period from power revenues at an average cost of 21 mills per kilowatt-hour.

h. Positive contributions toward the environmental quality of the study area would result from development of the Upper Susitna River Basin. Hydroelectric generation would conserve over 5.8 million tons of coal annually or 15 million barrels of oil annually. Improvements in air and water quality would result from reduction in coal-fired plants and reduction in the mining of coal.

i. We have not been able to identify any need for mitigation measures at this time. However, more detailed studies, including pre-impoundment studies of the reservoir areas and studies of fishery habitat below Devil Canyon, are planned during pre- and post-construction periods. Any mitigation measure found necessary and economically justified will be provided for at that time.

j. Early construction of access road to the projects would facilitate preconstruction planning activities and expedite construction and initial power on line.

k. Construction of the two dams and transmission system would be the responsibility of the Corps of Engineers and the operation and maintenance of the projects and transmission system would be the responsibility of the marketing agency. One-half of the separable investment cost allocated to reservoir recreation would be reimbursable and all costs of operation, maintenance and replacement of lands and facilities for recreation would be paid by non-Federal interests, all in accordance with the Federal Water Project Recreation Act, Public Law 89-72. All costs to power would be repaid to the Federal Treasury from power revenues.

RECOMMENDATIONS

The District Engineer recommends:

a. Construction by the Corps of Engineers of the Susitna River Project consisting of a combination of two dams and reservoirs designated as the Watana and Devil Canyon on the upper Susitna River, Alaska, and of transmission facilities and grid system for southcentral and interior Alaska, for hydroelectric power, flood control, and recreation in accordance with the selected plan described in this report, and with such modifications as in the discretion of the Chief of Engineers may be advisable, all at a Federal cost presently estimated at $1,520,000,000, exclusive of the cost of preauthorization studies.

b. That operation and maintenance of the projects and appurtenant transmission facilities be the responsibility of the marketing agency, such costs presently estimated at $2,400,000 annually, including the cost associated with major replacements.

Provided that, prior to start of construction of recreational facilities, responsible non-Federal entities provide assurances acceptable to the Secretary of the Army, they will, in accordance with the Federal Water Project Recreation Act, Public Law 89-72:

a. Administer land and water areas for recreation.

b. Pay, contribute in kind, or repay (which may be through water user fees) with interest, one-half of the separable cost of the project allocated to recreation, presently estimated to be $572,300.

c. Bear all costs of operation, maintenance, and replacement of lands and facilities for recreation, presently estimated to be $100,000 annually.

It is further recommended that authority for construction of necessary access roads to the projects be provided for in the authorization for advanced engineering and design. Such roads, estimated to cost $22,300,000, will provide necessary access for detailed preconstruction site investigations and facilitate timely construction of the projects.

All costs to power, presently estimated at $1,516,000,000 for construction, and $2,397,000 annually for operation, maintenance, and major replacements, are to be repaid to the Federal Treasury from power revenues.

CHARLES A. DEBELIUS
Colonel, Corps of Engineers
District Engineer

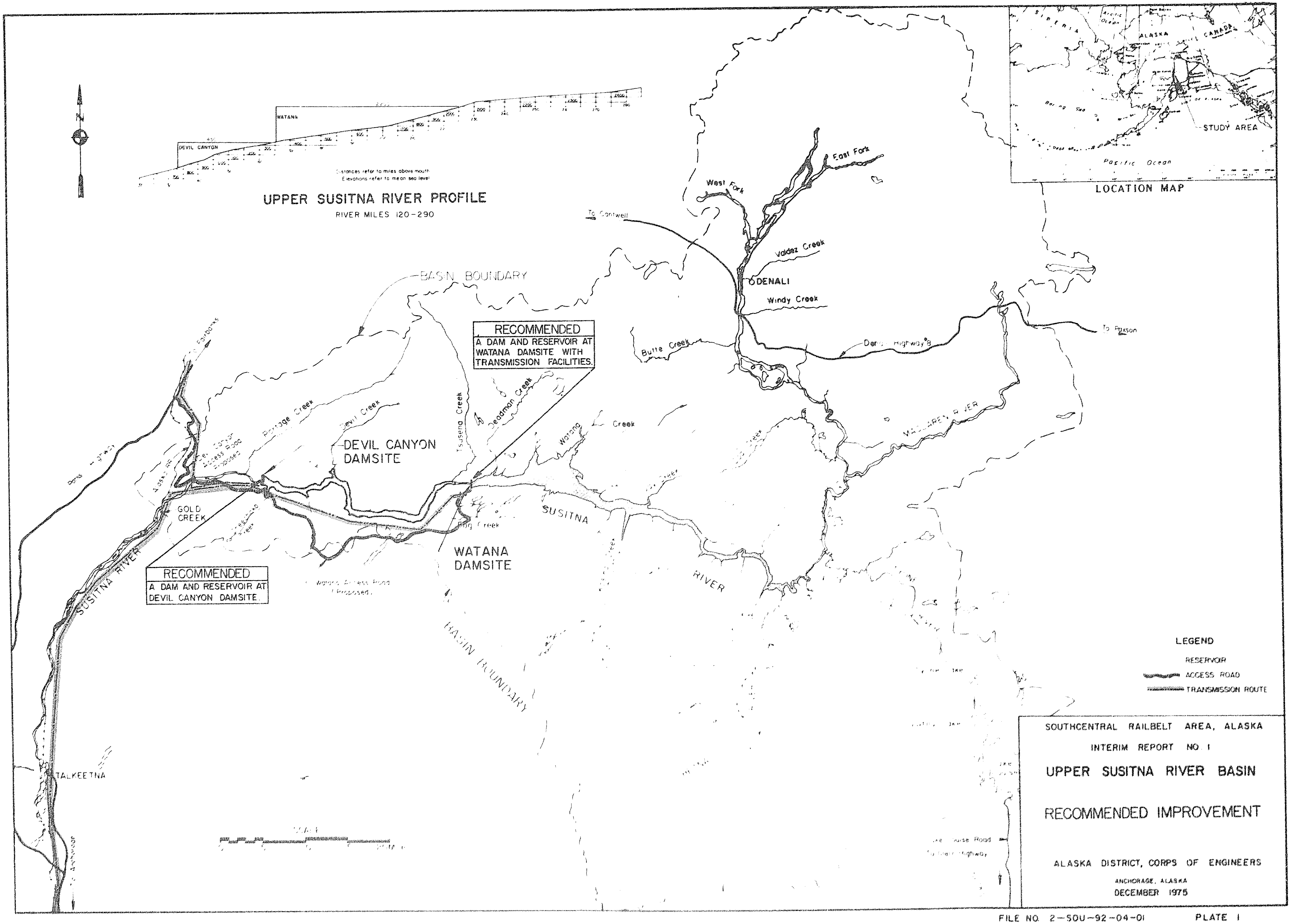
NPDPL-PF (12 Dec 75) 1st Ind
SUBJECT: Interim Feasibility Report, Upper Susitna River Basin, Alaska

DA, North Pacific Division, Corps of Engineers, 210 Custom House, Portland, Oregon 97209 31 December 1975

TO: Chief of Engineers

I concur in the conclusions and recommendations of the District Engineer.

WESLEY E. PEEL
Major General, USA
Division Engineer



SOUTHCENTRAL RAILBELT AREA, ALASKA

INTERIM REPORT NO. 1

UPPER SUSITNA RIVER BASIN

RECOMMENDED IMPROVEMENT

ALASKA DISTRICT, CORPS OF ENGINEERS

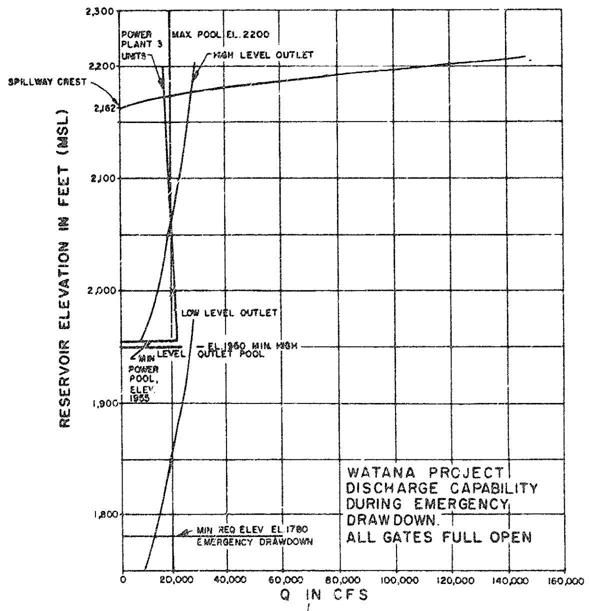
ANCHORAGE, ALASKA

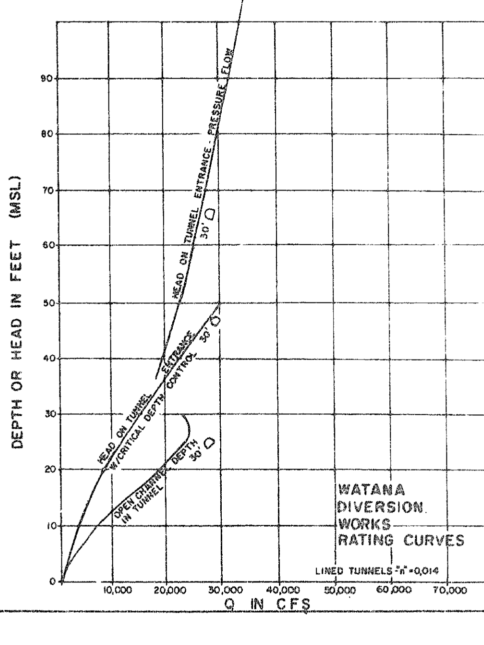
DECEMBER 1975

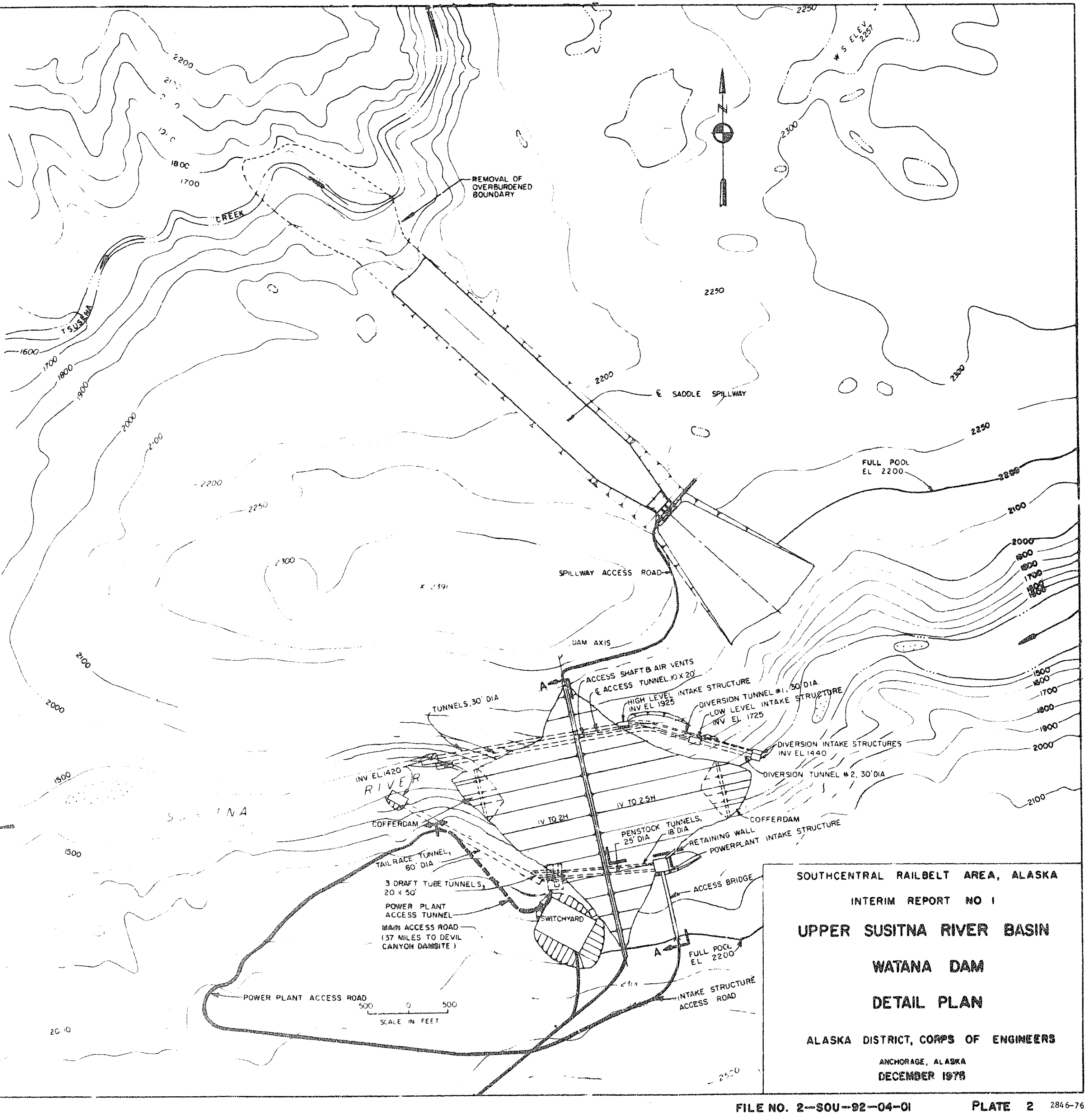
FILE NO. 2-SOU-92-04-01 PLATE 1

NOTES:

1. TOPOGRAPHIC CONTOURS WERE TAKEN FROM U.S.G.S. TOPOGRAPHY SCALE 1:63,360 TALKEETNA MOUNTAINS (D-4), ALASKA. VERTICAL DATUM IS MEAN SEA LEVEL (M.S.L.)
2. THERE ARE NO KNOWN EXISTING IMPROVEMENTS ON THIS PLATE.







SOUTHCENTRAL RAILBELT AREA, ALASKA

INTERIM REPORT NO. 1

UPPER SUSITNA RIVER BASIN

WATANA DAM

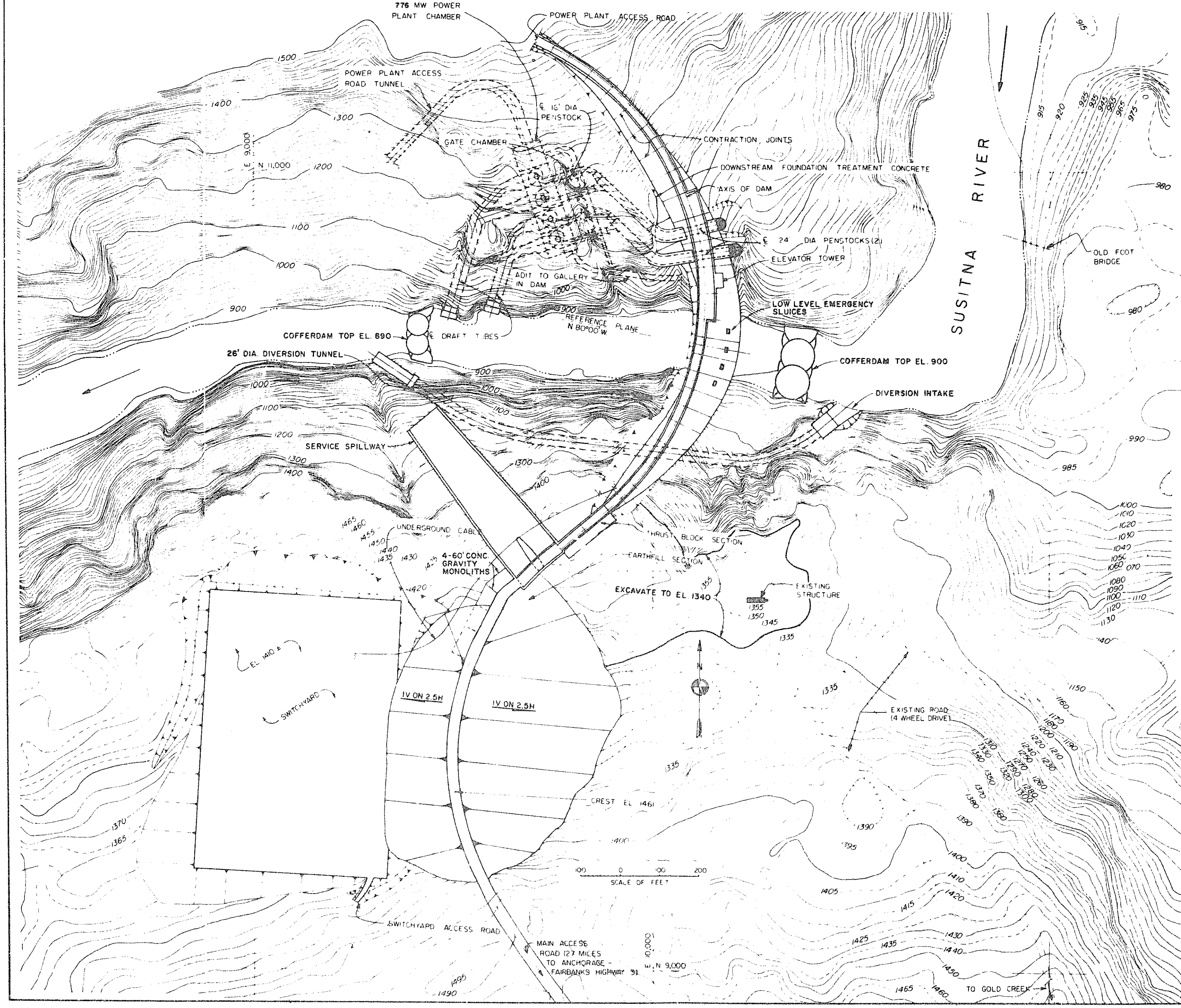
DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

ANCHORAGE, ALASKA

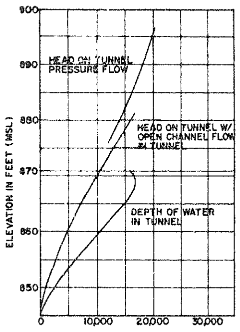
DECEMBER 1975

FILE NO. 2—SOU—92—04—01 PLATE 2 2846-76

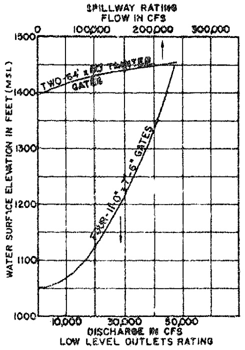


NOTES:

1. TOPOGRAPHY WAS COMPILED FROM AERIAL PHOTOGRAPHY WITH GROUND CONTROL. VERTICAL DATUM IS MEAN SEA LEVEL, (m.s.l.).
2. EXISTING IMPROVEMENTS WERE CONSTRUCTED TO OBTAIN INFORMATION AND DATA FOR EARLIER STUDIES.



DEVIL CANYON 26' ◯ DIVERSION TUNNEL



DEVIL CANYON RATING CURVES

SOUTHCENTRAL RAILBELT AREA, ALASKA

INTERIM REPORT NO. I

UPPER SUSITNA RIVER BASIN
DEVIL CANYON DAM
DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

ANCHORAGE, ALASKA

DECEMBER 1975

FILE NO. 2-SOU-92-04-01

PLATE 3