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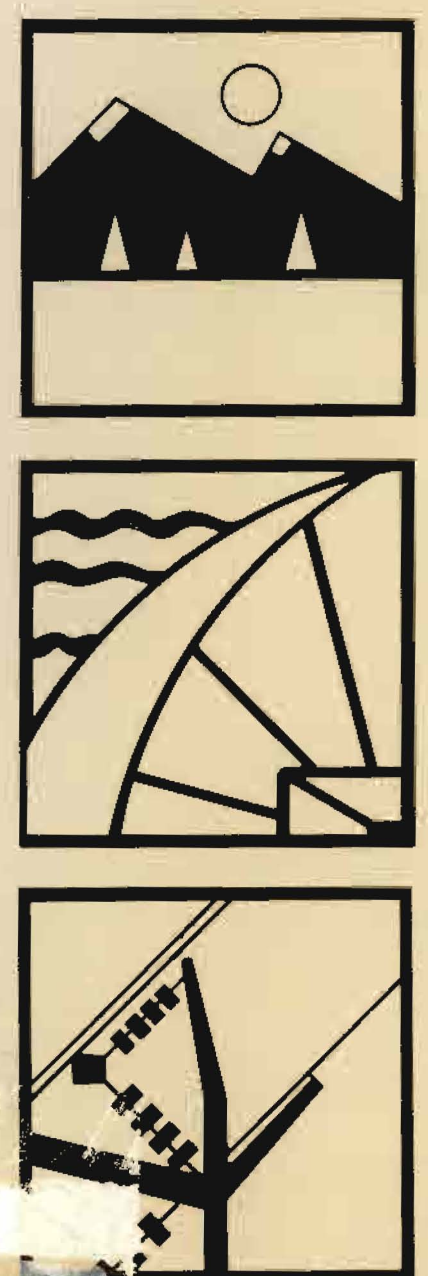

SUSITNA HYDROELECTRIC PROJECT

SUMMARY REPORT

MARCH, 1982

DRAFT

ALASKA POWER AUTHORITY

HARZA-EBASCO SUSITNA JOINT VENTURE
711 H STREET ANCHORAGE, ALASKA 99501 TEL. (907) 272 5585

March 24, 1986
1.17.4.2

Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, Alaska 99502

Attention: Mr. Donald McKay
Habitat Biologist

Subject: Susitna Hydroelectric Project
Document Transmittal

Dear Mr. McKay:

Alaska Department of Fish and Game has provided the enclosed errata sheets for the report entitled "Report No. 10: Preliminary Evaluations of Potential Fish Mitigation Sites in the Middle Susitna River" (Document No. 2908). The pages (one set) have been T-punched to accommodate report update.

Very truly yours,

Paul Lambert

Paul T. Lambert
Administrative Manager

klf

Enc: as noted

cc w/o Enc:
S. Ellingwood, Power Authority

226771/3

ALASKA POWER AUTHORITY

334 WEST 5th AVENUE · ANCHORAGE, ALASKA 99501
Phone: (907) 277-7641
(907) 276-0001

March 15, 1982

An Open Letter to the Public
At Large and To All Interested
Agencies and Organizations:

It is with great pleasure that I am providing for your review and comment the draft summary report on the Feasibility Study of the Susitna Hydroelectric Project. This summary draws upon material presented in the detailed feasibility report and supporting documents, to which reference should be made for a more comprehensive discussion of the various topics.

This report represents the culmination of more than two years of work, undertaken by Acres American Incorporated in accordance with the Plan of Study presented in February, 1980, and subsequent improvements and revisions which were largely prompted by your suggestions and concerns. In addition to the extensive technical and economic evaluation of the proposed development of the Susitna River Basin, the program has included a comprehensive evaluation of the environmental issues associated with the project. Public preferences identified in the course of several meetings held during the study period have been factored into the proposed plan, and we look forward to continuing this dialogue in the weeks and months to come. Public meetings are planned for late March and mid-April in Anchorage, Fairbanks, and Talkeetna.

Subsequent to these meetings, the Board of Directors of the Alaska Power Authority will be formulating a recommendation as to whether or not a license application should be filed and developmental activities continued.

Sincerely,

Eric P. Yould
Executive Director

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FRONTISPIECE — WATANA DAMSITE

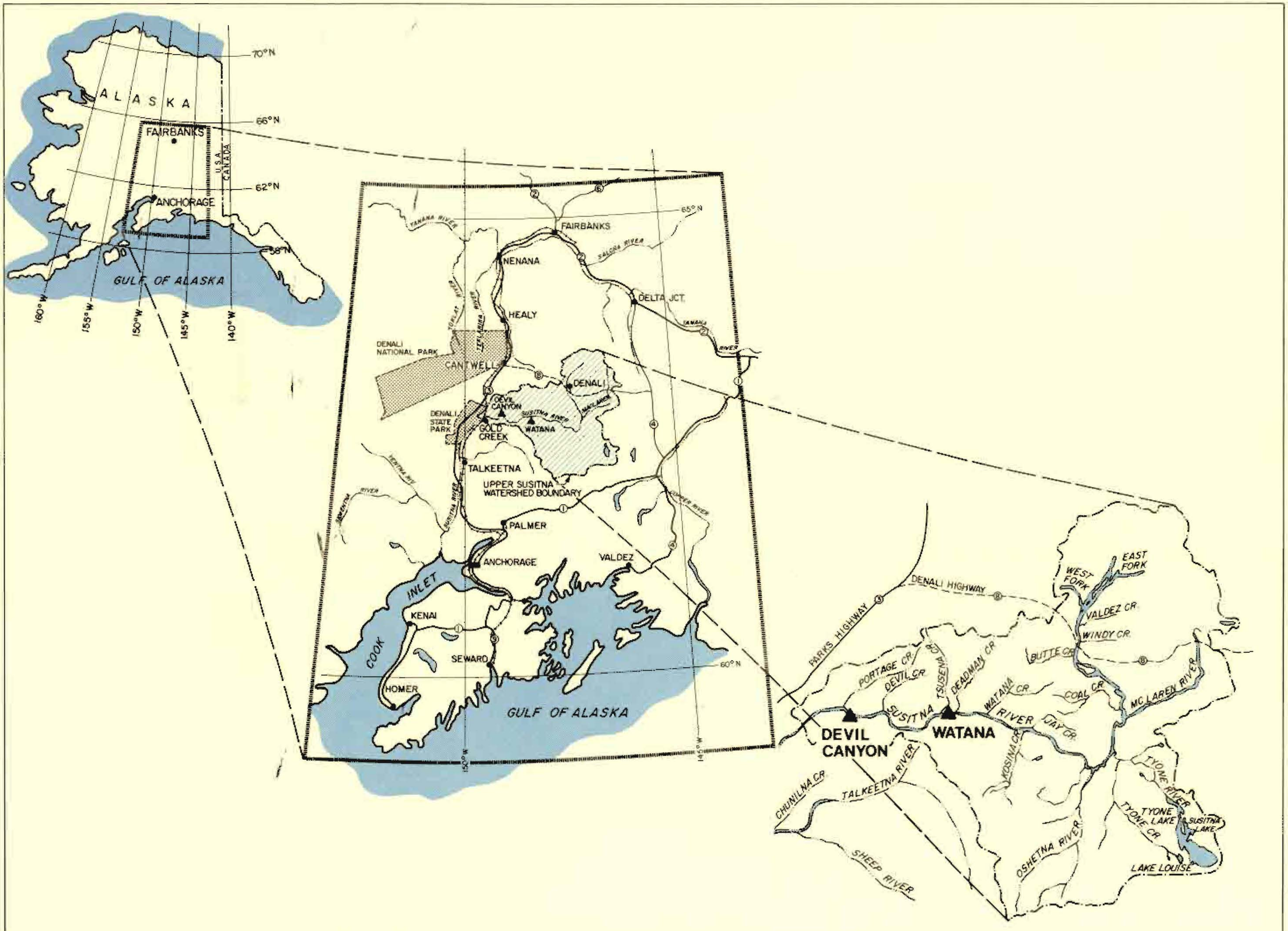


PLATE 1 **LOCATION PLAN**

INTRODUCTION

1

The Susitna River, with a drainage area of more than 19,000 square miles, is the sixth largest in Alaska. (See Plate 1.) Rising in the glacier-topped mountains of the Alaska Range about 90 miles south of Fairbanks, the river meanders across a broad alluvial fan for about 50 miles in a southerly direction before it turns westward and begins a 75-mile plunge between essentially continuous canyon walls. Turning once again to the south, it flows for another 125 miles before discharging into the upper reaches of Cook Inlet west of Anchorage. An important and productive fishery resource, the Susitna also contributes to the support of significant wildlife populations in the virtually untouched and relatively inaccessible lands across which it flows.

Contained entirely within the southcentral Railbelt region, the Susitna basin is strategically situated between the two largest Alaskan population centers of Anchorage and Fairbanks.

The extensive hydroelectric potential of the Susitna River first came to public attention in 1948 when the Bureau of Reclamation issued a report of its initial investigations there. Since that time, various development schemes have been advanced by public agencies and private organizations. A common thread in the many earlier reports is a virtually unanimous agreement that some project should proceed.

Acres American Incorporated was commissioned by the Alaska Power Authority, in December 1979, to conduct a detailed feasibility study in order to determine technical feasibility, economic viability, and environmental impacts of an optimal development in the basin. A rigorous program of field investigations, alternative plan evaluations, design studies, environmental studies, and economic analyses led to the production of a final draft feasibility report issued for public comment in March 1982. This document provides a summary of the detailed report.

Throughout the study period, an agressive public participation program was conducted by the Alaska Power Authority. Comments from interested organizations and individuals have greatly influenced the work. In addition, coordination with federal and state resource agencies has resulted in the selection of design criteria, project features, and operation plans which appear to offer balanced solutions to sometimes conflicting objectives.

A separate and independent study of alternatives to the Susitna project has been prepared by Battelle Pacific Northwest Laboratories under the terms of an agreement with the Office of the Governor, State of Alaska. Both the Battelle Report and the detailed feasibility study are available for public review at libraries throughout the Railbelt.

THE EXTENSIVE HYDROELECTRIC POTENTIAL OF THE SUSITNA RIVER FIRST CAME TO PUBLIC ATTENTION IN 1948...

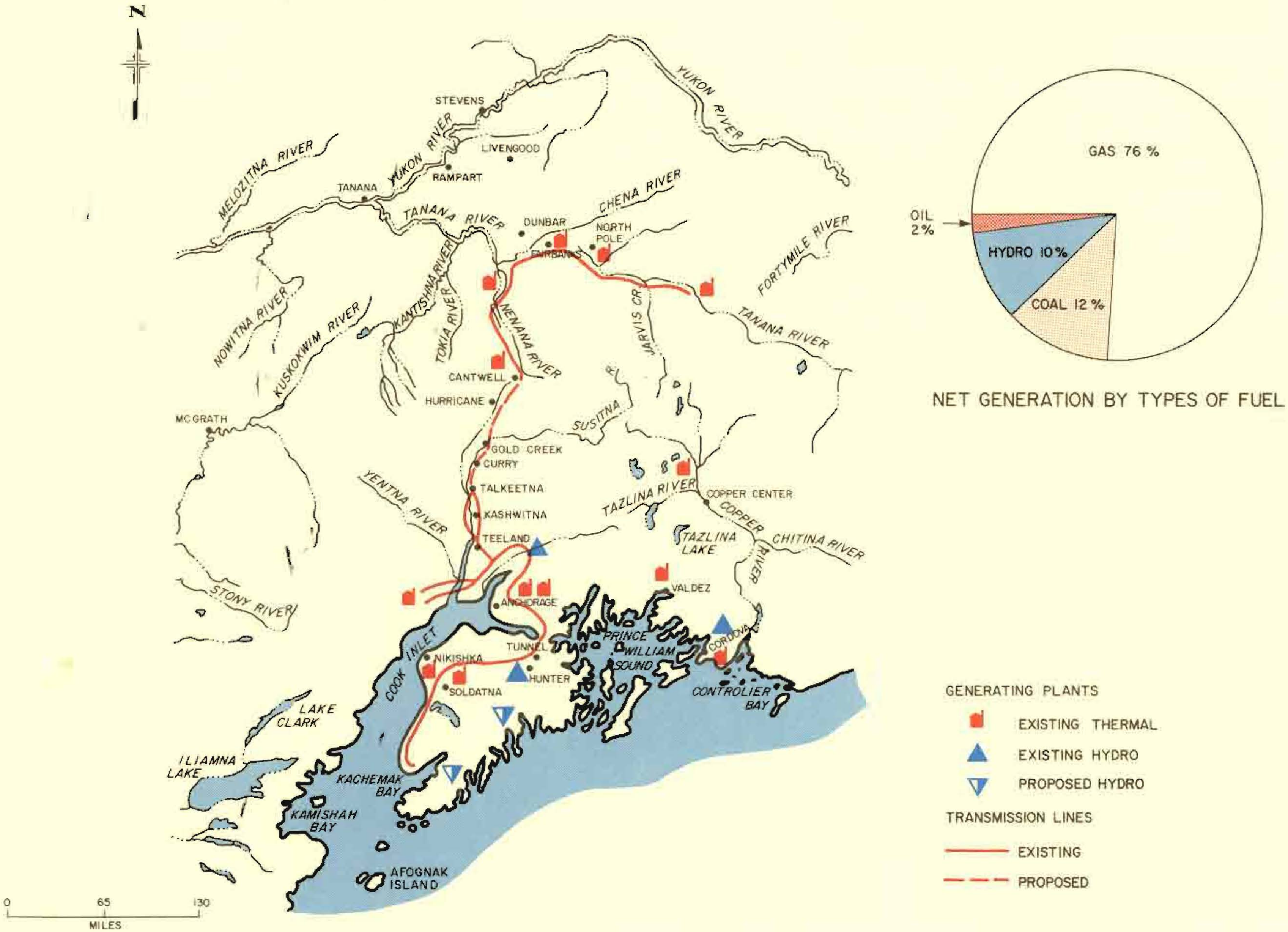


PLATE 2 GENERATING AND TRANSMISSION FACILITIES

NEEDS

Current Generation System

About 90 percent of the current total net generation of electricity in the Railbelt depends upon the use of fossil fuels. Anchorage and other communities in the south now enjoy relatively low-cost energy because of their proximity to Cook Inlet gas fields and to existing small hydroelectric plants. In the north, the Fairbanks-Tanana Valley area depends primarily upon coal (which is mined near Healy) and a small amount of oil. Plate 2 provides a breakdown of generation by fuel types.

At the present time, the northern and southern load centers are not interconnected. Thus, generating systems have evolved independently over the years in these two areas. The total installed capacity in the Railbelt, exclusive of military generation, is nearly 1000 MW.

Five electric utility companies serve the Anchorage-Cook Inlet area. The two largest, Achorage Municipal Light and Power and Chugach Electric Association, operate the bulk of the generating resources. Alaska Power Administration, a federal agency, operates the 30-MW Eklutna hydroelectric plant, marketing wholesale power to several of the utility companies. Aside from the Eklutna plant, most generating resources in the south are concentrated around urban areas or near Beluga, west of Anchorage, where natural gas is piped from various wells. Transmission interconnections between utility systems generally exist in the Anchorage-Cook Inlet area.

The Fairbanks-Tanana Valley area is served by two utility companies: Golden Valley Electric Association and Fairbanks Municipal Utilities System. A coal-fired plant operated near the mine mouth at Healy supplies energy to communities to the north through a 138-kV transmission line.

Military bases in the Railbelt independently operate generating units, as does the University of Alaska at Fairbanks. The Glennallen-Valdez area, east of Anchorage, is served by the Copper Valley Electric Association.

Scheduled Additions

An intertie permitting transfer of up to 70 MW of power between Anchorage and Fairbanks is currently planned by the Alaska Power Authority. It will provide an opportunity for economic interchange of energy and will permit sharing reserve capacity. Provisions have been made for integrating the intertie into a future larger transmission system in the event that the Susitna project or other regional-scale facility is constructed.

THE TOTAL INSTALLED CAPACITY IN THE RAILBELT, EXCLUSIVE OF MILITARY GENERATION, IS NEARLY 1000 MW.

Five new generating units are currently planned in the Railbelt. Two hydroelectric plants will provide about 97 MW with perhaps another 45 MW of spinning reserve. The larger of these is the Bradley Lake Project east of Homer, now being considered at alternative capacities of either 90 MW or 135 MW. Grant Lake would add a further 7 MW. One gas-fired combined-cycle unit and two gas turbines will add another 160 MW. When scheduled retirements and new additions are accounted for, the total system capacity in the early 1990s is expected to be about 1200 MW.

Historical Trends

Between 1940 and 1978, electricity sales in the Railbelt grew at an average annual rate of 15.2 percent - roughly twice that of the nation as a whole. Plate 3 illustrates the historical growth in electric energy demand between 1965 and 1980. Although the rate of demand increase in the Railbelt has consistently exceeded the national average, the gap has narrowed in recent years as the Alaskan economy has matured. Past high growth rates can be attributed both to rapid population increases and to installation of electric service in households which had not previously been served.

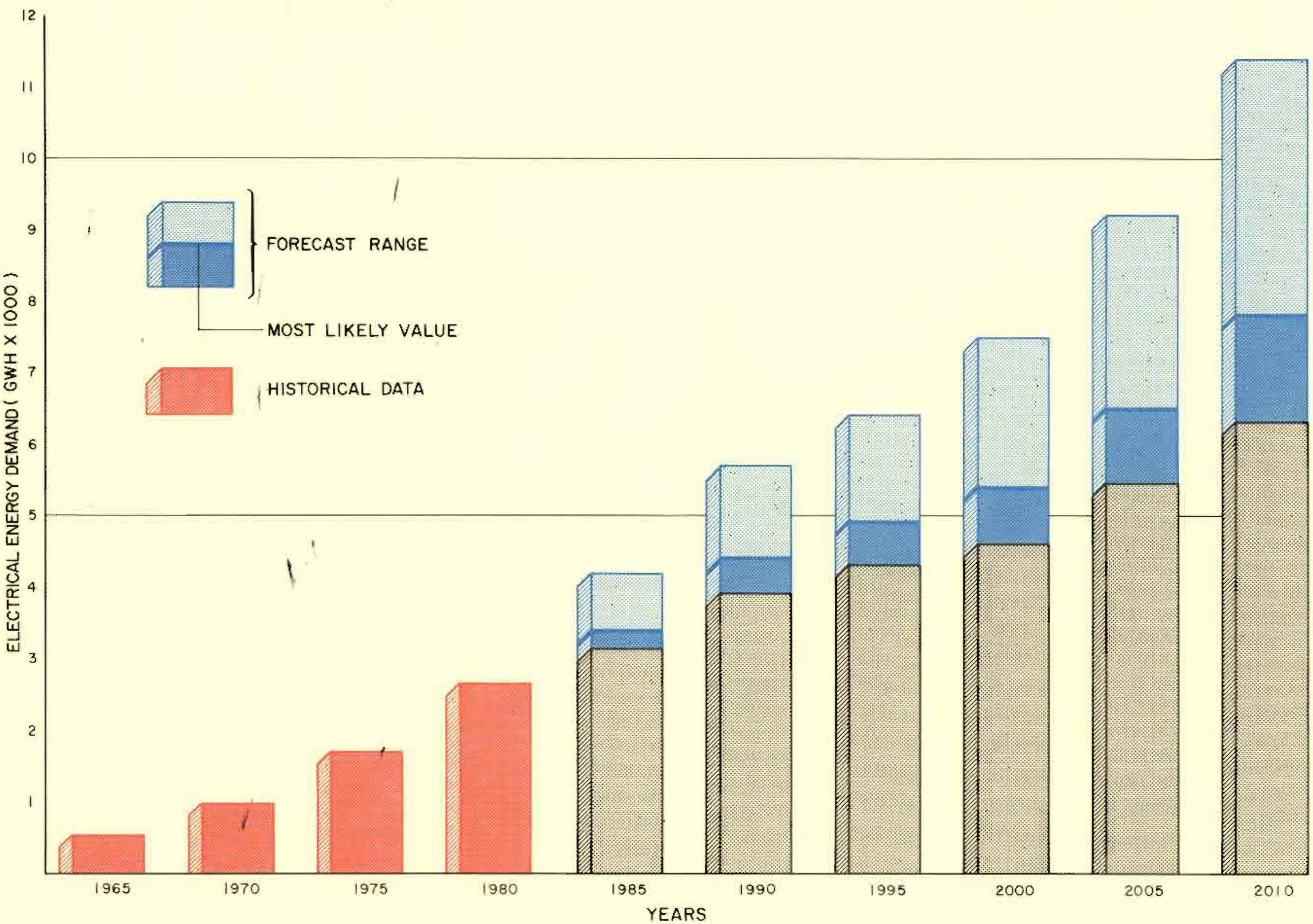


PLATE 3 **RAILBELT ENERGY DEMANDS**

Currently, about 47 percent of utility sales are to residential customers, 1 percent for miscellaneous use (e.g. street lighting), and the remaining 52 percent to the commercial-industrial-government sector. This split has been relatively constant during the past decade.

Forecasts of Future Demand

A great deal of uncertainty is necessarily associated with the preparation of demand and load forecasts. Population growth, industrial activity, government expenditures, energy prices, conservation measures and a variety of other factors will affect — and are frequently affected by — future demand. To ensure objectivity, a range of load forecasts was independently derived. Initial work accomplished by the Institute for Social and Economic Research, University of Alaska, was subsequently updated by Battelle Pacific Northwest Laboratories (Battelle). Plate 3 illustrates the December 1981 Battelle forecasts used in the final evaluation of Susitna project viability. Between 1981 and 2010, the mid-range forecast suggests that electrical and energy demand will grow at an annual rate of about 3.5 percent, with the high and low range limits at about 4.6 percent and 2.8 percent, respectively. The mid-range value was selected as the base case for planning future generation needs in the Railbelt. Sensitivity tests were conducted for the high and low cases (see Section 10).

All forecasts include substantial electricity conservation due to the cost of power. In the low case, industrial developments such as mining Beluga coal, U.S. Borax mining, a petrochemical plant, and a Valdez refinery are assumed not to occur. These developments do appear in the high case, but no additional major capital projects for which planning has not yet commenced are assumed. In each case, demand was sensitive to energy costs. Thus, more energy demand is assumed to occur for the least cost alternative than for higher cost alternatives.

Military bases and self-supplied industries are assumed to continue to generate electricity for their own needs and they are not included in the demand forecast.

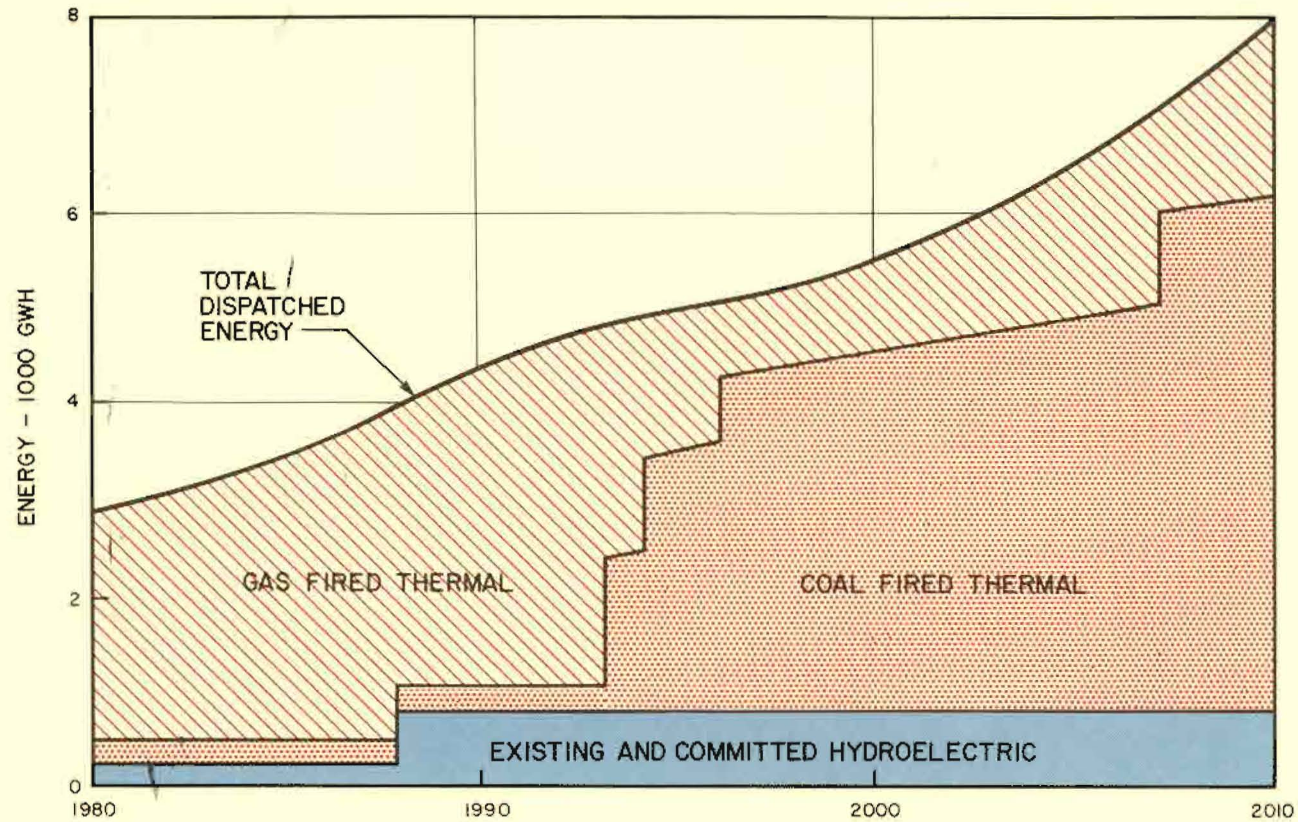
Electric space heating which now warms about 21 percent of the households in Anchorage and 9 percent in Fairbanks is assumed to change in relation to price differences between electricity and alternative heating fuels. Growth in population and tourism varies from case to case. Battelle indicated that the chances of realizing lesser and greater demand than the mid-range forecast are equal.

Requirements for Additional Capacity

Under the mid-range forecast, currently scheduled additions are sufficient until 1993 to meet rising demand as well as to replace aging units which must be retired. Between 1993 and 2010, about 1400 megawatts of capacity must be added to the system to meet additional demand as well as to replace aging units.

. . . THE MID-RANGE FORECAST SUGGESTS THAT ELECTRICAL ENERGY DEMAND WILL GROW AT AN ANNUAL RATE OF ABOUT 3.5 PERCENT.

If required system expansion occurs by continued use of the thermal generating plants, a shift toward increased use of coal will be necessary not only because the Cook Inlet gas reserves may be insufficient to sustain long-term reliance upon natural gas in the face of increased demand but also because sharp increases in gas prices will occur in the next decade as old supply contracts expire. The installation of thermal (coal- or gas-fired) plants to meet the demand would offer the consumer no protection against rising costs, since fuel prices will continue to be exposed to inflation and to extraordinary escalation occasioned by world market conditions. Thus, it is appropriate to consider what other options may exist, as well as to ponder important implications and risks which might be associated with them.



VALUES OF SELECTED PARAMETERS

	200 MW COAL - FIRED PLANT (BELUGA)	70 MW GAS-FIRED COMBUSTION TURBINE
FUEL PRICE (1982 $/MMBTU)	$ 1.43	$ 3.00
ANNUAL FUEL PRICE ESCALATION:		
1982 - 2000	2.6 %	2.5 %
2000 - 2010	1.2 %	2.0 %
CAPITAL COSTS (1982 $/KW)	$ 2,242	$ 636
ANNUAL CAPITAL COST ESCALATION	1.8 %	1.8 %
INFLATION RATE	0 %	0 %
DISCOUNT RATE	3 %	3 %
ANNUAL OPERATING AND MAINTENANCE COSTS		
FIXED (1982 $/KW)	$ 16.83	$ 2.70
VARIABLE (1982 MILLS/KWH)	0.60	4.84
ASSUMED USEFUL LIFE (YEARS)	30	30

PLATE 4 **BASE CASE INSTALLATION SEQUENCE**

OPTIONS

3

In Battelle's preparation of load and demand forecasts, consideration was given to the extent to which reasonable and extreme conservation measures might be taken to minimize growth in electricity consumption. Indeed, conservation assumptions contributed in part to the earlier noted major decrease in growth rate from historical trends to alternative future expectations. It follows that the post-1993 demand must be met by physically installing additional generating units. An additional consideration, regardless of load growth, is the possible value of substituting new generation modes for existing fossil fuel-fired facilities subject to significant cost increases.

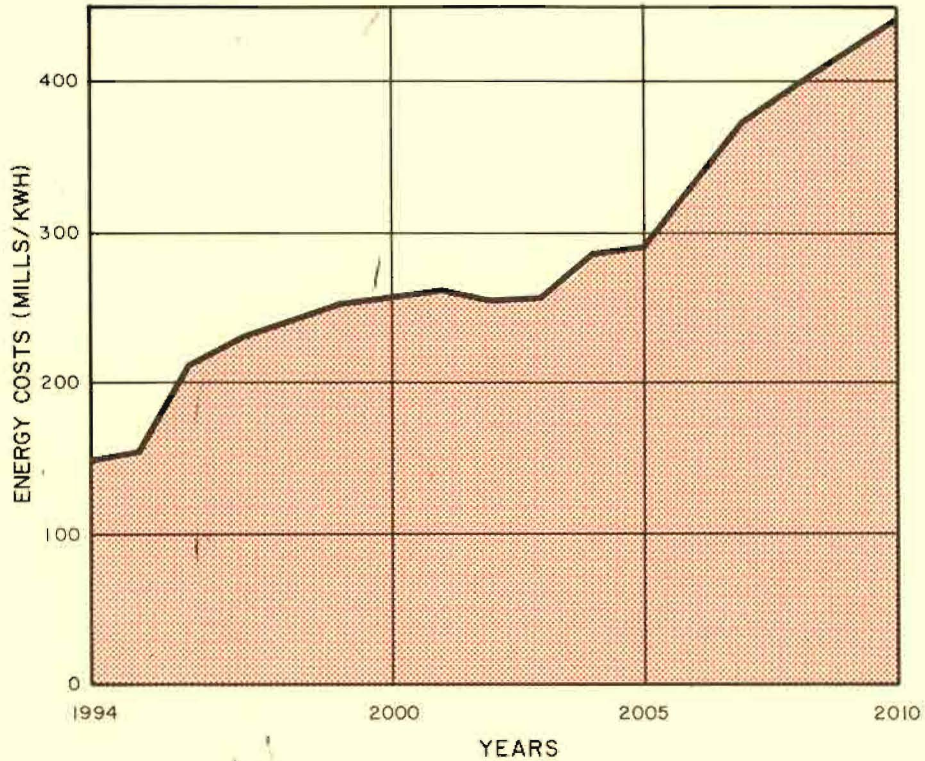
While it was not the purpose of the Susitna feasibility study to define the preferred alternative to Susitna development, it is nonetheless true that a reasonable "without Susitna" plan had to be developed as the basis for determining the nature, phasing, and economic viability of the apparent optimum Susitna project.

A computerized generation planning model, Optimized Generation Planning (OGP), is commonly used in the utility industry to assist in making decisions about future system expansion. This tool was employed to develop an apparent least-cost non-Susitna thermal generation plan. Given a list of possible additions — each with associated capacity, capital costs, fuel requirements and costs, operating and maintenance costs, reliability and availability data — the model selects appropriate additions on an annual basis throughout the planning period. Plate 4 illustrates the installation sequence developed for the "all thermal" non-Susitna plan, together with a tabulation of selected additions and key cost parameters. It is this plan which provides a base case for comparing alternative Susitna developments and for evaluating net benefits.

Although different methodologies and planning models were employed, the base case thermal plan shown on Plate 4 is similar to that produced by Battelle as Plan 1A in the independent alternatives study.

Certain non-Susitna hydroelectric options are available in the Railbelt. Of these, the most attractive from an economic standpoint would appear to be the Chakachamna project, located about 80 miles west of Anchorage. Chakachamna does not appear in the base case plan primarily because it may have a substantial fishery impact and because studies to date have been insufficient to determine expected capital costs with precision. Even so, as will be seen in Section 10, sensitivity analyses were conducted to determine the extent to which Chakachamna development would change net project benefits.

. . . THE BASE CASE THERMAL PLAN . . . IS SIMILAR TO THAT PRODUCED BY BATTELLE . . .



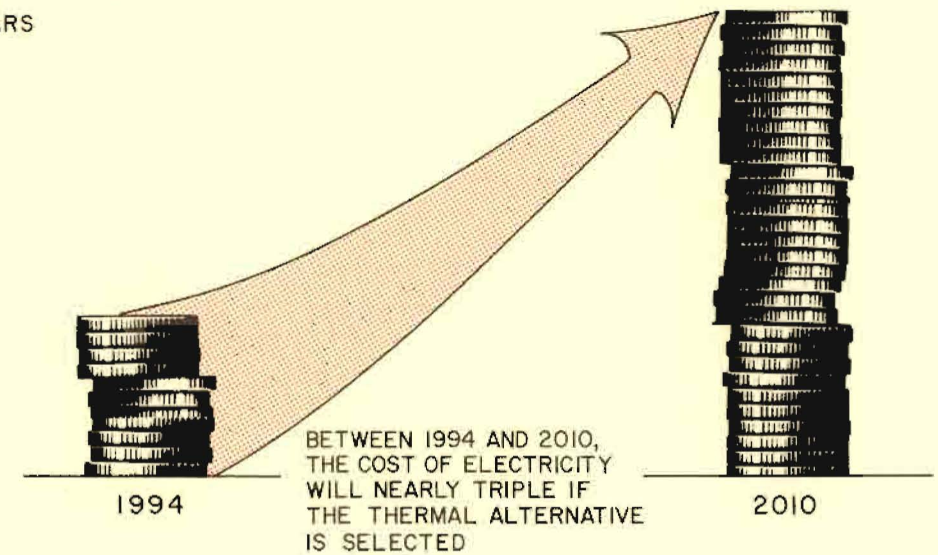


PLATE 5 **ANNUAL COSTS - BASE CASE**

Future Electric Energy Costs

If the base case plan is implemented, certain relatively dramatic changes in Railbelt energy costs will occur during the study period, as shown on Plate 5. In part, the expected electricity price rise can be ascribed to the insidious effects of inflation, assumed to average about 7 percent per annum through 2010. In part, the compounding effects of continuing fuel cost escalation over and above inflation will be translated into higher electricity bills. But other influences come into play as well, and they represent important considerations.

Not shown on Plate 5, but nonetheless significant to the consumer, particularly in Anchorage, is the fact that between 1982 and 1993, many of the long-term contracts now held by utility companies for very favorably priced Cook Inlet gas will expire. Not only will major increases in electric energy costs result from the requirement by local utility companies to purchase gas at market prices, but also known Cook Inlet gas reserves may have been depleted in the early 1990's to the point that reliance upon natural gas as the principal fuel for electric energy generation would no longer be possible. The availability during the study period of North Slope gas near Fairbanks remains uncertain. Even if the gas pipeline is built, however, the gas price is projected to be higher than that for the Cook Inlet resource. For these reasons, use of North Slope gas for electric energy generation is not considered a viable alternative.

The base case plan calls for the addition of two 200-MW coal-fired steam plants at Beluga in 1993-94. Coal mining is assumed to occur at Beluga and an export market for Beluga coal is assumed to exist. To recover the investment in these plants and to account for anticipated major increases in gas costs, as well as inflation and fuel price escalation above the underlying inflation rate, the wholesale price per kWh for electricity will have risen by 1994 to 145 mills (14.5¢) per kWh and will continue to rise thereafter. It is this price trend against which any proposed hydroelectric development on the Susitna River must compete.

If the mid-range forecast is realized, another 200-MW coal-fired plant will be required, probably near Nenana, in 1996 — accounting for the sharp increase between 1995 and 1996 shown on Plate 5. By 2007, a 200-MW coal-fired plant must be added, probably at Beluga. In the meantime, a number of gas turbines must be installed to maintain system peaking capability, to satisfy reserve requirements, and to replace similar units which will have reached the end of their useful operating life. Existing and planned hydroelectric plants are included in the base case plan and no hydroelectric units are assumed to retire during the study period. If the Bradley Lake Project is not constructed, costs for the non-Susitna plan will be greater than those shown on Plate 5.

An important assumption in the development of the base case plan has been that coal mining operations in the Beluga fields will have been conducted on a commercial scale within the next decade. Even with the assumed transition from gas to coal as the principal fuel for Railbelt electricity generation, coal demand within Alaska will have to be supplemented by substantial coal export requirements before opening the Beluga fields becomes an economically wise decision. Thus, there is some risk associated with reliance upon the Beluga coal scenario. The energy prices reflected on Plate 5 would rise dramatically if Healy fields were to represent the only reasonable coal source or if the only market for Beluga coal were to be for electric energy generation in Alaska.

AN IMPORTANT ASSUMPTION . . . HAS BEEN THAT OPERATIONS IN THE BELUGA FIELDS WILL START WITHIN THE NEXT DECADE.

It may be anticipated that, if primary dependence is placed upon fossil fuels for energy generation, electricity costs will rise after 2010 at a rate similar to that reflected in the last five years shown on Plate 5. As will be seen in Section 11 of this report, development of the upper Susitna basin could result in suppression of long-term growth in energy prices and a true saving to consumers. Even so, important potential risks and environmental impacts must be pondered.

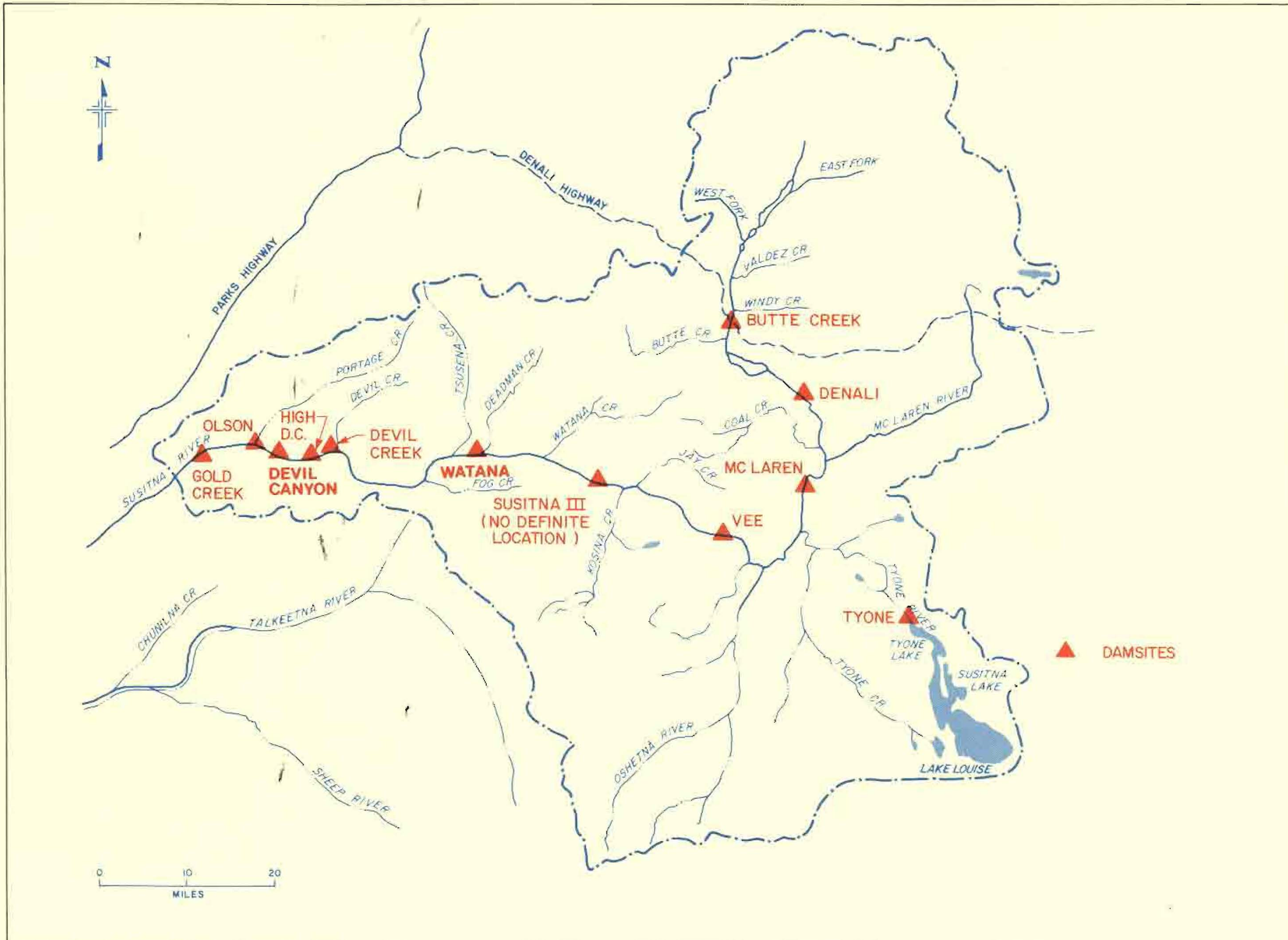
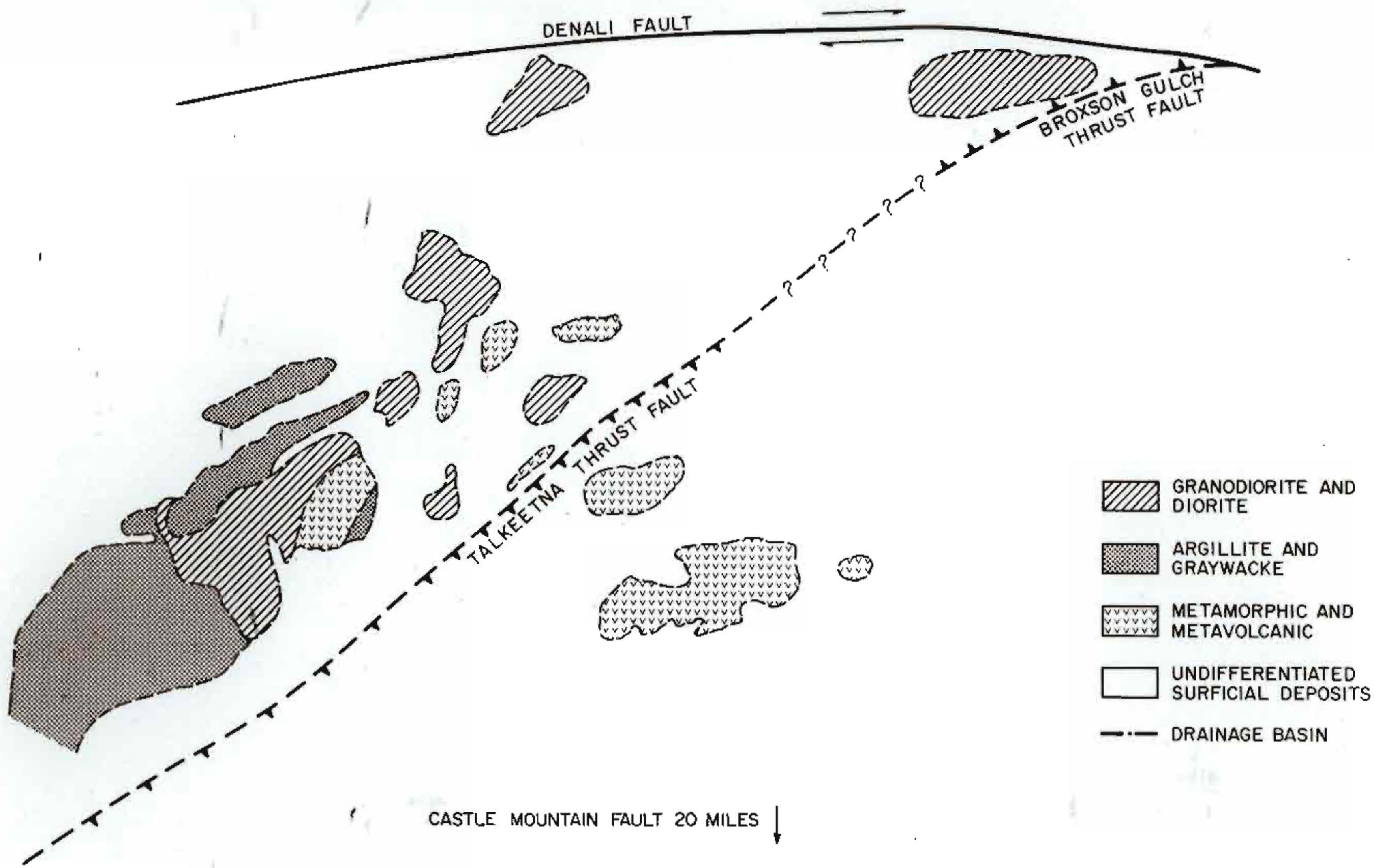


PLATE 6 UPPER SUSITNA BASIN


DENALI FAULT
BROXSON GULCH THRUST FAULT
TALKEETNA THRUST FAULT
GRANODIORITE AND DIORITE
ARGILLITE AND GRAYWACKE
METAMORPHIC AND METAVOLCANIC
UNDIFFERENTIATED SURFICIAL DEPOSITS
DRAINAGE BASIN
CASTLE MOUNTAIN FAULT 20 MILES

Basin Characteristics

The Susitna River exhibits two distinct seasons of flow. Between May and October, snow and glacial melt, together with heavy rainfall, contribute about 90 percent of the annual total flow. Modest winter flows occur in the mainstem, and many smaller tributaries freeze solid in the coldest months. Less than 20 percent of the total Susitna discharge into Cook Inlet is contributed by the Susitna river above Devil Canyon. As the river turns in a southerly direction after leaving the steep narrow canyons of its westerly leg, major tributaries, including the Chulitna, Talkeetna and Yentna Rivers, contribute to the bulk of the total discharge which ultimately reaches the mouth.

Occasional high flows in the Susitna contribute to the formation of productive habitat both for fisheries and for wildlife as land is alternately inundated and exposed and as sedimentation and debris is picked up and redeposited. However, Portage Creek, just west of Devil Canyon (see Plate 6), is the furthest point to which salmon migrate. Raging torrents in the canyons beyond Portage Creek present a natural barrier to further upstream movement. Floods with return periods of 50 to 10,000 years range from 48,000 cfs to 200,000 cfs at Devil Canyon. The probable maximum flood (expected never to occur) is 366,000 cfs at Devil Canyon.

The upper Susitna basin has a complex geology, as will be seen on the overlay for Plate 6. A history of at least three periods of major tectonic deformation contributes to this complexity. Volcanic flows and limestones, formed 250 to 300 million years ago, are overlain by sandstones and shale. A tectonic event dated approximately 150 million years ago resulted in the intrusion of large diorite and granite plutons. Marine deposition of silts and clays followed. Faulting and folding of the Talkeetna Mountains area in the late-Cretaceous period (65 to 100 million years ago) resulted in the formation of argillites and phyllites near Devil Canyon. The diorite pluton that forms the bedrock of the Watana site was intruded into sediments and volcanics about 65 million years ago. Andesite and basalt flows nearby were intruded after this plutonic intrusion.

A third regional uplift about 20 to 40 million years ago raised portions of the basin as much as 3000 feet. Since then, erosion, glaciation, and active downcutting of streams and rivers have combined to form the current topography.

The upper basin lies in a highly seismic region. Historical earthquakes within 200 miles of the upper Susitna River have generally originated from deep within the earth (the Benioff Zone) and from the crustal seismic zone. Major faults include the Denali fault system and the Castle Mountain fault. The Denali fault lies 30 to 40 miles north of potential dam sites and it is capable of causing earthquake magnitudes of 8.0 on the Richter scale. The Castle Mountain fault is 60 to 70 miles to the south and could cause earthquakes of magnitude 7.5. The most dominant earthquake source, however, is the Benioff Zone, which itself contains two distinct segments separated by a transition zone of low seismic activity. The shallower portion could produce earthquakes of 8.5 magnitude within about 57 miles of Devil Canyon and 40 miles of Watana. The deeper segment could generate 7.5 magnitude about 19 miles closer to Devil Canyon. The absence of faults with recent displacement in the vicinity of the sites sets an upper limit on the magnitude of an event that could have occurred in the crustal zone without detection. However, a remotely possible "terrain" earthquake occurring with a magnitude of 6.25 less than 6 miles from the sites must also be considered.

It follows that if hydroelectric development does proceed in the basin, proposed projects must be sufficiently robust to withstand occasional high floods and major earthquakes. At the same time, impacts on important downstream fishery resources and on wildlife populations in general must be minimized.

THE UPPER BASIN LIES IN A HIGHLY SEISMIC REGION.

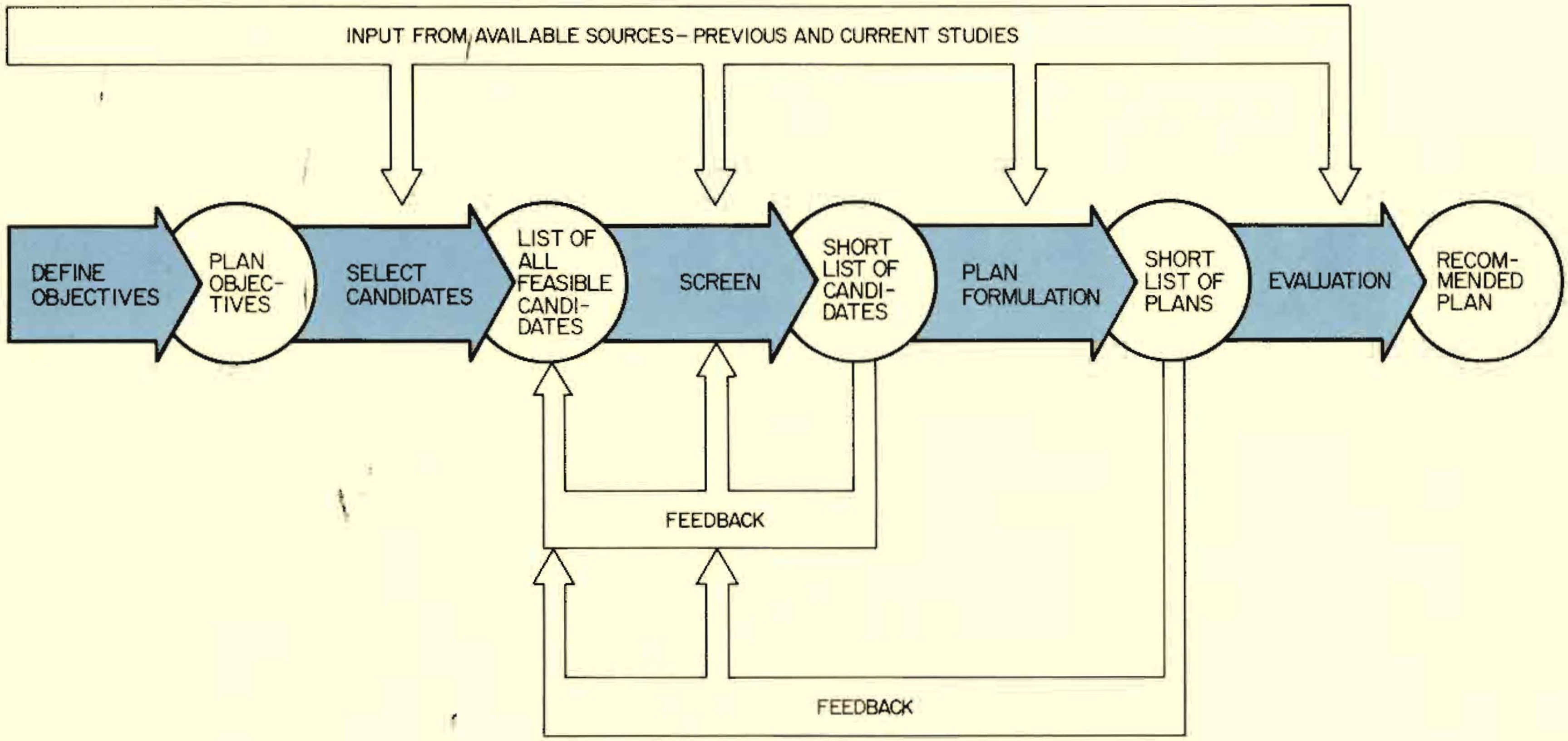


PLATE 7 DEVELOPMENT SELECTION PROCESS

Plan Formulation

A generalized plan formulation and selection process was developed to guide the various planning studies. Plate 7 illustrates the procedure. Of the numerous planning decisions made, perhaps the most important were the selection of the preferred Susitna basin development plan and appropriate routes for access and transmission lines. In broad terms, a large number of possible choices was subjected to successively tighter criteria screens until a preferred plan was defined.

The steep narrow canyons in the upper basin offer an unusually large number of possible dam sites. They offer opportunities as well for considering a range of alternative developments at any single site. Plate 6 locates the many sites which were reviewed in the development selection process.

After detailed screening to account for important technical, economic, and environmental criteria, three general plans emerged as being appropriate for more detailed evaluation: (1) the Watana and Devil Canyon sites, (2) High Devil Canyon and Vee sites, and (3) a combination of a dam at Watana, a relatively low regulation dam midway between Watana and Devil Canyon, and a tunnel from the low dam to a downstream portal near Devil Canyon.

A technically sound preliminary design was produced for each plan, and preliminary cost and energy production estimates were prepared. The OGP model was run to evaluate economic viability as well as to determine optimum dates upon which the various stages of alternative Susitna developments should be operable. Quantitative and qualitative environmental and social data were compiled and comparisons were made. Sensitivity tests were conducted to determine the extent to which differences between expectations and the potential extreme values of certain key parameters affected each plan.

The Watana-Devil Canyon plan was found to be clearly superior to development of the High Devil Canyon and Vee sites on economic, energy contribution, and environmental grounds; and it was found marginally better in terms of social criteria. Both plans are technically feasible.

The Watana development is common to both remaining plans. When compared to the tunnel alternative, the Devil Canyon dam was found to be significantly better in terms of economic and energy contribution criteria, and marginally favored for social criteria. The tunnel scheme was moderately favored environmentally. While both plans appear to be technically feasible, however, a greater degree of technical uncertainty was associated with the tunnel plan. A clear economic advantage of the Devil Canyon dam was judged to outweigh the reduced environmental impact associated with the tunnel scheme.

Thus, the selected arrangement involves construction of dams at the Watana and Devil Canyon sites. It lends itself well to staged development since the second dam can be deferred or accelerated as a function of actual future growth in Railbelt energy demand.

. . . THE SELECTED ARRANGEMENT INVOLVES CONSTRUCTION OF DAMS AT THE WATANA AND DEVIL CANYON SITES.

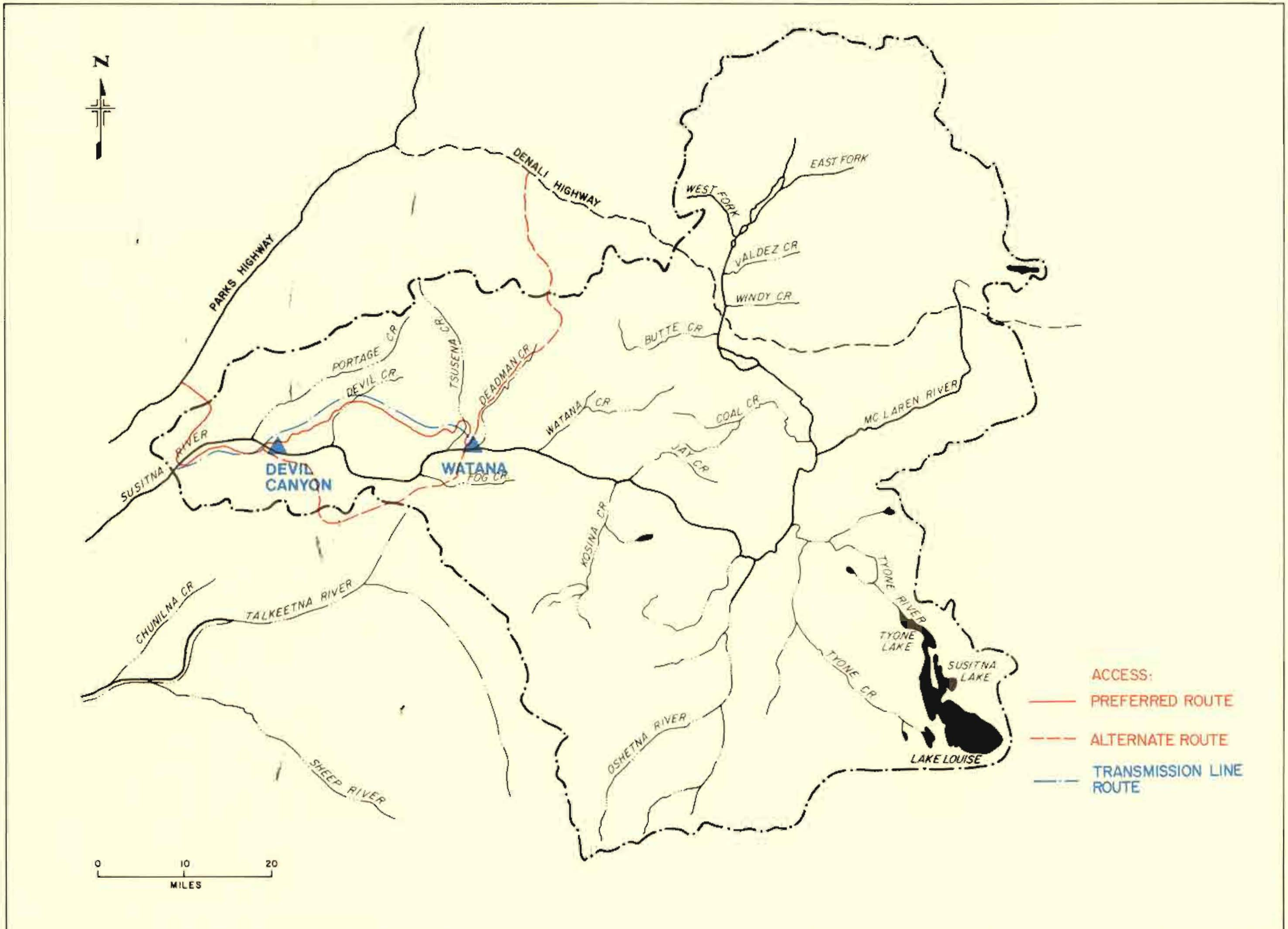


PLATE 8 **ACCESS ROUTES**

Access Route Selection

The generalized plan formulation and selection process illustrated on Plate 7 was also applied to the selection of important access and transmission line routes. Plate 8 displays various candidate choices considered in the upper basin.

Three main access corridors emerged after initial screening. Each was assessed by conducting environmental and engineering studies, reviewing aerial photography, and preparing geologic maps. Important objectives included allowing construction to proceed on schedule, minimizing construction and logistics costs, facilitating operation and maintenance, minimizing adverse biological impacts, accommodating preferences of local communities and Native landowners, and accounting for the concerns of interested resource agencies.

A total of eleven different plans was produced from the three main corridors.

No single plan was found to be consistently best in meeting all objectives. Even so, tradeoffs were made between environmental impacts and socio-cultural impacts, and a preferred access plan was selected. Plate 8 traces this route. Important features include: provisions for limited access between Gold Creek and the Watana site by way of a pioneer road to commence in mid-1983; deferment of road access from the Parks Highway until after award of a federal license for the project; rendering the pioneer road impassable in the event that the project does not proceed; use of special construction techniques to minimize environmental damages; controlling public access; and special mitigation recommendations, such as a full service construction camp, to minimize undesired changes in local communities.

Transmission Line Routes

Transmission line route selection followed a similar pattern to that for access routes. Initial corridor selection resulted in narrowing the options from 22 possible choices to three which reasonably met established objectives. The selected transmission line route generally parallels the Alaskan Railroad between Willow and Fairbanks. Between Willow and Anchorage, the route extends in a southerly direction to a point west of Anchorage, where undersea cables will cross Knik Arm. Between Willow and Healy, the route would utilize the transmission corridor previously selected by the Power Authority for the Railbelt Intertie.

Plate 8 displays that portion of the transmission line route which lies within the upper basin.

NO SINGLE ACCESS PLAN WAS FOUND TO BE CONSISTENTLY BEST IN MEETING ALL OBJECTIVES.

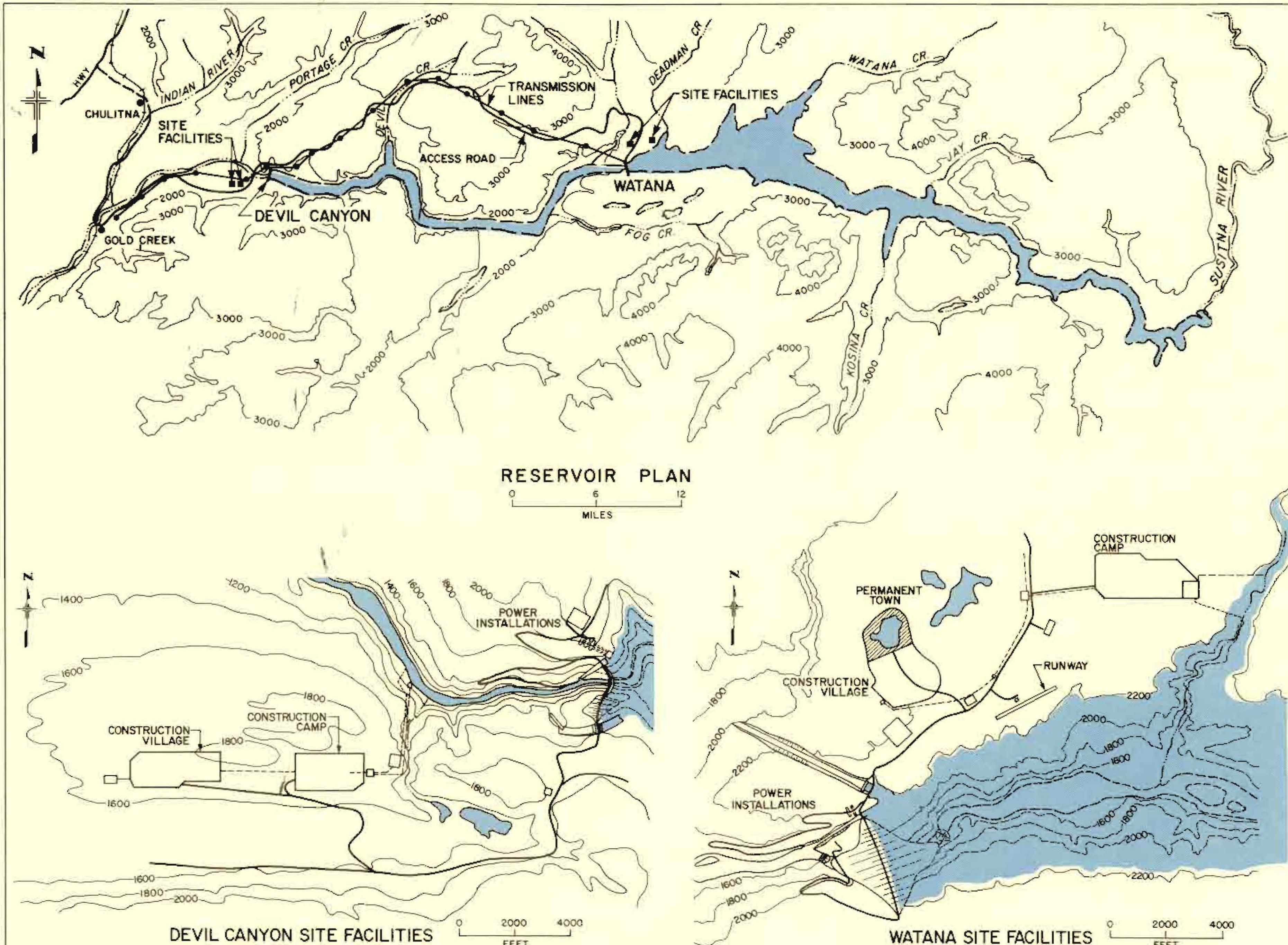


PLATE 9 PREFERRED DEVELOPMENT PLAN

PROPOSED DEVELOPMENT

5

The proposed plan for full basin development is shown on Plate 9. In the event that the State decides to develop this plan, two major reservoirs will be formed. The larger reservoir extends 48 miles upstream of the Watana site and has an average width of about one mile and a maximum width of 5 miles. The Watana reservoir has a surface area of 38,000 acres and a maximum depth of about 680 feet at normal operating level.

The Devil Canyon reservoir is about 26 miles long and one-half mile wide at its widest point. A surface area of 7,800 acres and a maximum depth of about 550 feet represent conditions at normal operating level.

Temporary construction camps near each of the dam sites will be removed after construction is complete, but a permanent townsite will remain in the project area to accommodate the needs of the operating and maintenance staff. Appropriate recreational, educational, medical, commercial, sanitation, water supply, and religious facilities will be included in the townsite. Access and egress will follow the same route as was originally provided for construction purposes. A permanent 6,000-foot airstrip will be constructed.

Staged development is planned to provide maximum flexiblity in meeting actual growth in energy demand as it develops. An initial installation of 680-MW of capacity at Watana will be available to the system in 1993 and 340 MW will be added in 1994. If the mid-range forecast is realized, Devil Canyon will be completed by 2002 with an installed capacity of 600 MW. Even so, the commencement of construction and the completion date for this second stage can be deferred or advanced as necessary to meet future needs.

THE WATANA RESERVOIR WILL BE 48 MILES LONG AND THE DEVIL CANYON RESERVOIR 26 MILES LONG.

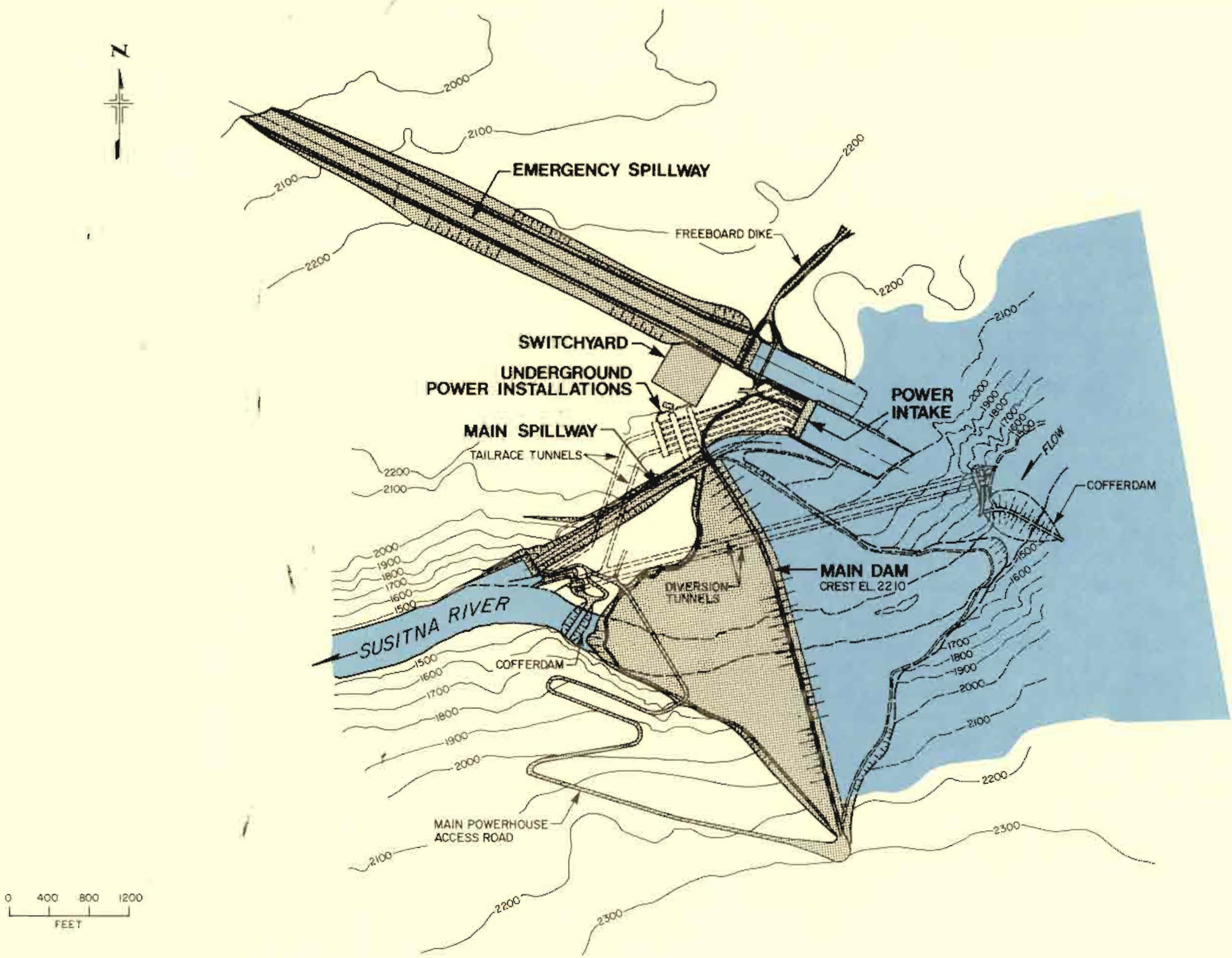


PLATE 10 WATANA GENERAL ARRANGEMENT

Watana Details

The general arrangement for development of the Watana site is illustrated on Plate 10 and a sketch appears on Plate 27. Comparisons of embankment and arch dam alternatives at Watana showed significant cost advantages in favor of the former.

The main dam will be an earthfill structure with a maximum height of 885 feet, a crest length of 4,100 feet, and a total volume of about 62,000,000 cubic yards. During construction, the river will be diverted through two concrete-lined diversion tunnels, each 38 feet in diameter, in the right (north) bank of the river. Upstream and downstream cofferdams will protect the dam construction area from floods with return frequencies of 50 years or less.

The power intake includes an approach channel in rock on the right bank. A multi-level, reinforced concrete, gated intake structure capable of operating over a full 140-foot drawdown range will facilitate maintenance of downstream water quality (especially temperature control — an important consideration for Susitna fishery resources). Six concrete-lined penstocks, each 17 feet in diameter, lead to steel-lined sections terminating in an underground powerhouse complex where six Francis turbines, each producing 250,000 hp at rated head, can be accommodated. The initial stage includes four such units together with 180-MVA generators to be installed by 1993, followed in 1994 by the final two units. The turbines discharge into a surge chamber and thence to the river via two concrete-lined 30-foot diameter tailrace tunnels, one of which connects with one of the original diversion tunnels. A transformer gallery is provided upstream of the powerhouse cavern. Oil filled cables extend from the transformer gallery to a surface switchyard.

Misleading
Not proven.

Outlet facilities incorporated into the arrangement will discharge floods with return frequencies of 50 years or less through six fixed-cone valves to minimize undesirable downstream nitrogen supersaturation — another important consideration for fishery resources.

Two spillways will also be provided. Flows with return frequencies between 50 years and 10,000 years will be handled by a main chute spillway on the right bank. An emergency spillway, also on the right bank, will permit discharge of the probable maximum flood without overtopping the dam.

OUTLET FACILITIES WITH FIXED-CONE VALVES WILL MINIMIZE UNDESIRABLE DOWNSTREAM NITROGEN SUPERSATURATION.

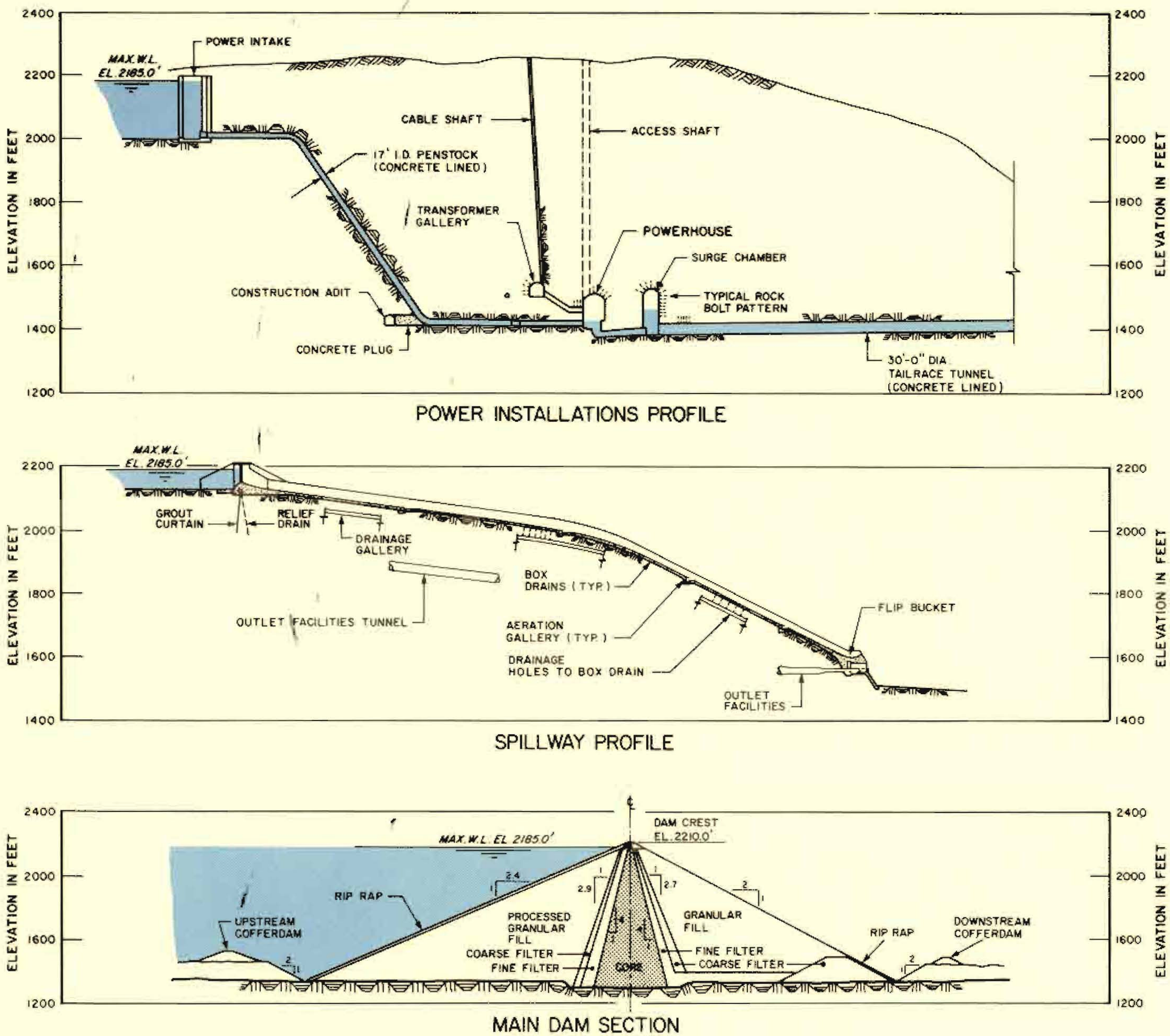


PLATE 11 **WATANA DETAILS**

Details of certain components at the Watana site are shown on Plate 11.

The main dam at Watana will be among the highest in the world. Its 885-foot height will exceed that of the highest completed embankment dams in North America at Mica Creek in British Columbia (794 feet) and at Oroville in California (771 feet). Two dams under construction in the USSR will exceed 1,000 feet, but only one dam higher than 800 feet has been completed there.

At least seven large (over 500-feet high) embankment dams have been built in seismically active areas. The proposed core width, upstream and downstream slopes, and other parameters of the Watana design are consistent with and generally more conservative than corresponding average values for precedent structures. Even so, special features are incorporated in the Watana section to provide additional safeguards against the effects of seismic loading.

The dam foundation will be excavated to solid rock throughout its cross-section and allowances have been made for extensive consolidation and curtain grouting. Grouting will be accomplished from underground galleries, after which the same tunnels will be used to facilitate drilling drainage pressure relief holes.

The core of the main dam is a trapezoidal section, separated from granular fill sections by coarse and fine filter zones. Rip rap protection is provided upstream and a coarse filter zone will be placed at the downstream toe.

Field investigations conducted to date have provided supporting data for selection of the proposed general Watana arrangement. Even so, extensive data collection is expected to continue into the construction phase to ensure the safety and reliability of the various structures. One area of particular concern is a buried (relict) channel which runs from a point upstream of the proposed dam site to Tsusena Creek, a distance of about 1.5 miles. This channel represents a potential source of leakage from the Watana reservoir and remedial measures may be required to guarantee the integrity of the reservoir rim through the channel area. Allowances have been made in the project estimate to account for this feature. If no major problems are identified in continuing field investigations of the relict channel, construction costs will probably be less than those indicated in Section 8 of this report.

THE MAIN DAM AT WATANA WILL BE AMONG THE HIGHEST IN THE WORLD.

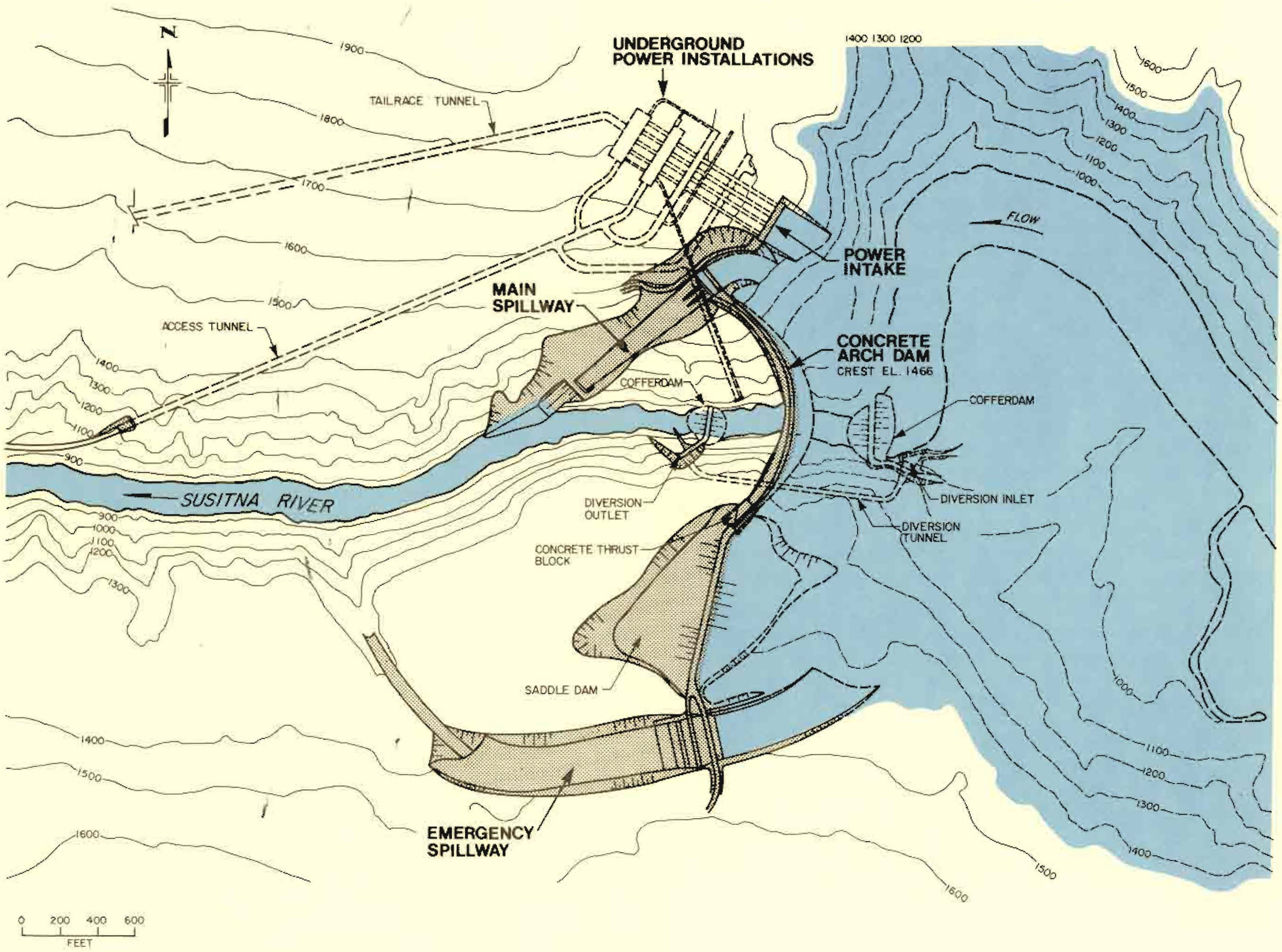


PLATE 12 DEVIL CANYON GENERAL ARRANGEMENT

Devil Canyon Details

Plate 12 illustrates the general arrangement for development of the Devil Canyon site and a sketch is presented on Plate 28.

The narrow "V" shaped canyon allows a number of alternative dam types to be considered. Detailed analysis indicated that a thin arch concrete dam is preferred over either a rock-fill embankment dam or a concrete gravity arch dam.

The main dam will be a double-curved arch structure with a maximum height of about 645 feet and a crest elevation of 1463 feet. The crest will be a uniform 20-foot width and the maximum base width will be 90 feet. The center section will be founded on a concrete pad, carried to bedrock beneath the river sediments, and the exteme upper portion of the dam will terminate in concrete thrust blocks located on the abutments. A two-center configuration will be adopted for the arches to counteract the slight asymmetry of the valley and to give more uniform stress distribution across the dam. A rock-fill saddle dam on the left (south) bank of the river will be constructed to a maximum height of about 245 feet above foundation level.

Flow during construction will be diverted through a single 30-foot diameter concrete-lined pressure tunnel in the left bank. Cofferdams and the diversion tunnel provide adequate protection during construction against floods with return periods of 25 years or less. The selection of a lesser return period than that used at Watana takes into account a shorter construction period, the availability of regulation at the then completed upstream Watana dam, and the fact that not only is the main concrete dam at Devil Canyon less susceptible to damage than an earthfill dam if it is overtopped during construction, but also that outlet facilities at the base of the dam will have been constructed well before the entire dam is completed.

The power intake on the right bank will include an approach channel in rock leading to a reinforced concrete gate structure which will accommodate a maximum drawdown of 55 feet. Four concrete-lined penstocks, each 20 feet in diameter, will lead to an underground powerhouse, where four 225,000 hp (at rated head) Francis turbines will be housed. A single 38-foot diameter tailrace tunnel will lead from a surge chamber downstream of the powerhouse cavern.

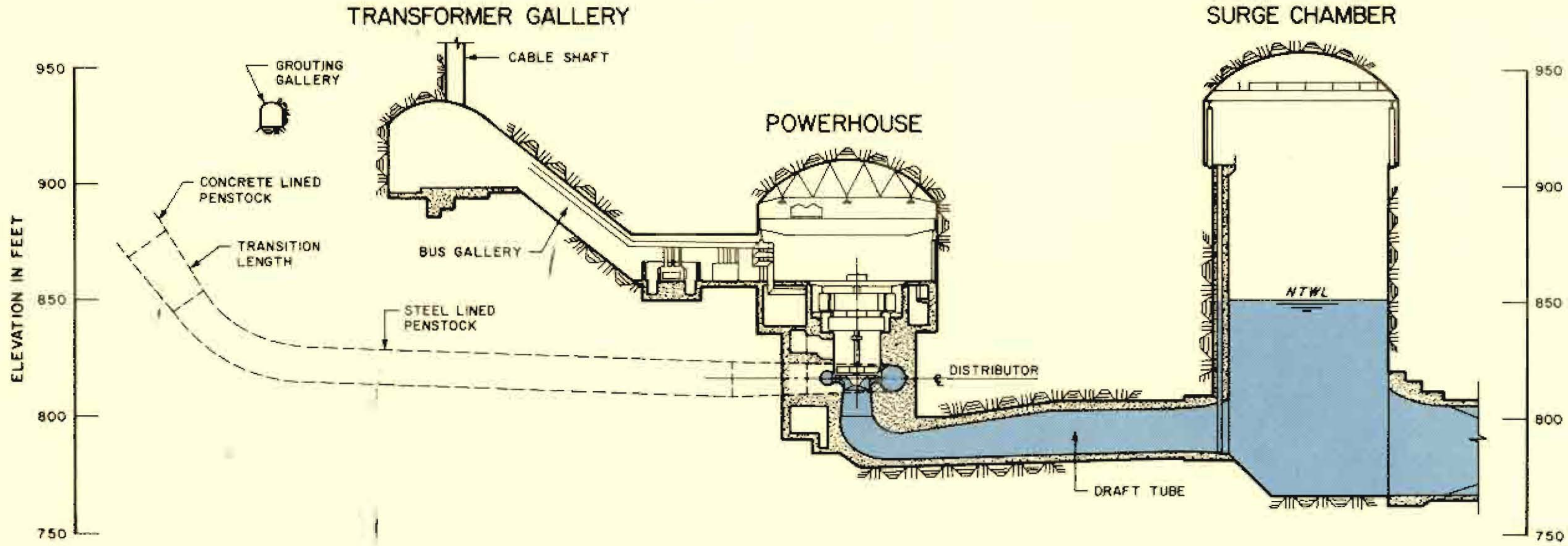
The transformer gallery, oil-filled cable arrangement, and surface switchyard are similar in concept to those at Watana.

Seven individual outlets, each with a fixed-cone valve, will be located in the lower part of the main dam and will be designed to discharge all floods with return frequencies less than 50 years. Once again, this approach, though more costly than conventional surface spillways, minimizes nitrogen supersaturation problems downstream.

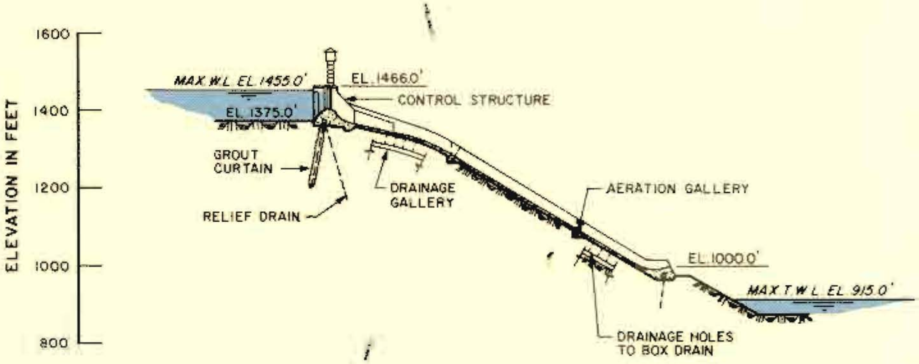
Floods with return periods between 50 and 10,000 years will be handled by a chute spillway on the right bank, similar in design to that for Watana. An emergency spillway on the left bank will permit discharge of the probable maximum flood without overtopping the dam.

how much Flow?

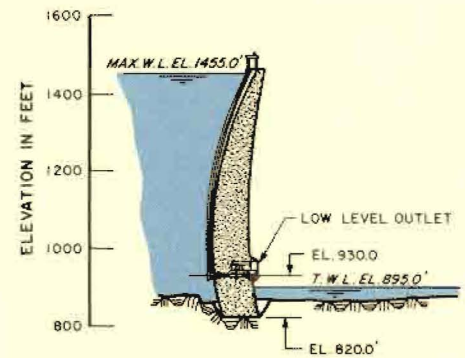
THE MAIN DAM AT DEVIL CANYON WILL BE A DOUBLE-CURVED CONCRETE ARCH STRUCTURE.



POWER INSTALLATIONS SECTION



MAIN SPILLWAY PROFILE



ARCH DAM SECTION

PLATE 13 DEVIL CANYON DETAILS

Details of certain components at Devil Canyon are shown on Plate 13.

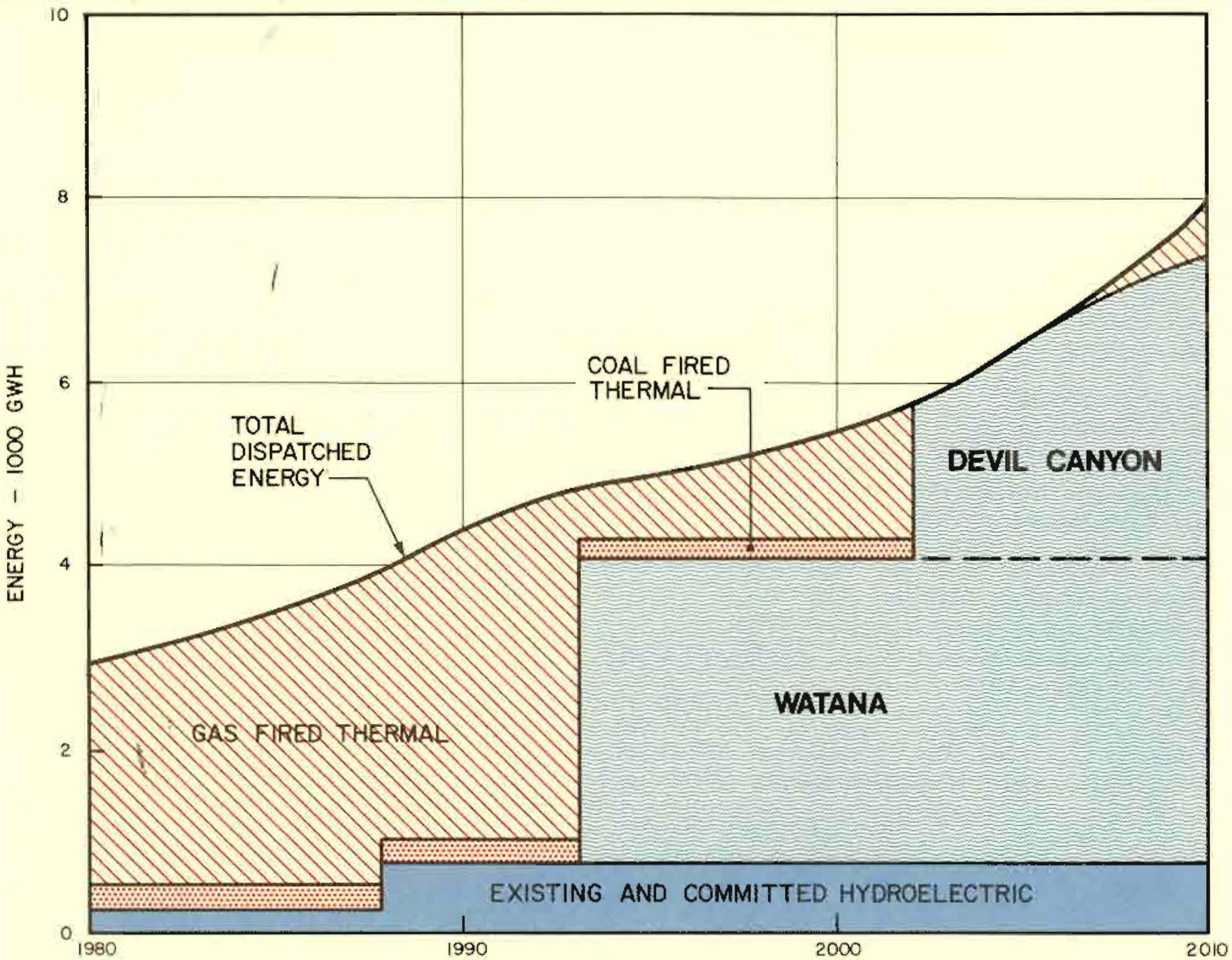
Eight major arch dams greater than 650-feet high have been constructed in the world, the highest being 858 feet at Veneto, Italy. A new arch dam is under construction at Inguiri in the USSR. Upon completion in 1985, it will be 892 feet high.

The Devil Canyon thin arch dam will be designed to withstand dynamic loadings from intense seismic shaking. High earthquake loadings at the 548-foot high Vidraru Arges dam in Rumania and at the 372-foot high Pacoima dam in California have been experienced with no loss of structural integrity.

The arch dam will be founded on sound bedrock located 20 to 40 feet below the normal bedrock surface. To minimize stress concentrations and to increase symmetry, rock surfaces will be trimmed. Consolidation grouting will be provided over the whole of the foundation area and a double grout curtain up to 300 feet deep will run the length of the dam. As at Watana, galleries will be provided both to facilitate grouting and for the purpose of collecting any seepage to be drained through holes drilled downstream of the grout curtain.

The saddle dam is similar in design to that for Watana, except that the saddle dam shells will be rock-filled.

EIGHT MAJOR ARCH DAMS GREATER THAN 650 FEET HIGH HAVE BEEN CONSTRUCTED.



VALUES OF SELECTED PARAMETERS

	1020 MW AT WATANA (FIRST STAGE)	1020 MW WATANA 600 MW DEVIL CANYON (SECOND STAGE)
FUEL PRICE (1982 $/MMBTU)	0	0
CAPITAL COSTS (1982 $/KW)	$ 3,643	$ 3,186
ANNUAL CAPITAL COST ESCALATION	1.8 %	1.8 %
INFLATION RATE	0 %	0 %
DISCOUNT RATE	3 %	3 %
ANNUAL OPERATING AND MAINTENANCE COSTS (1982 $ IN MILLIONS)	$ 10.0	$ 15.2
USEFUL LIFE FOR ECONOMIC ANALYSIS (YEARS)		50
EXPECTED USEFUL LIFE OF PROJECT (YEARS)		100

PLATE 14 **SUSITNA INSTALLATION SEQUENCE**

PROJECT OPERATION

6

The OGP model described in Section 3 was used to determine the optimum project staging sequence under each of the demand forecasts. As may be seen from Plate 14, in the case of the mid-range forecast, the Susitna project represents a major portion of the net energy generation when its various stages come on line, though this share would gradually decrease after 2010 if demand continued to rise.

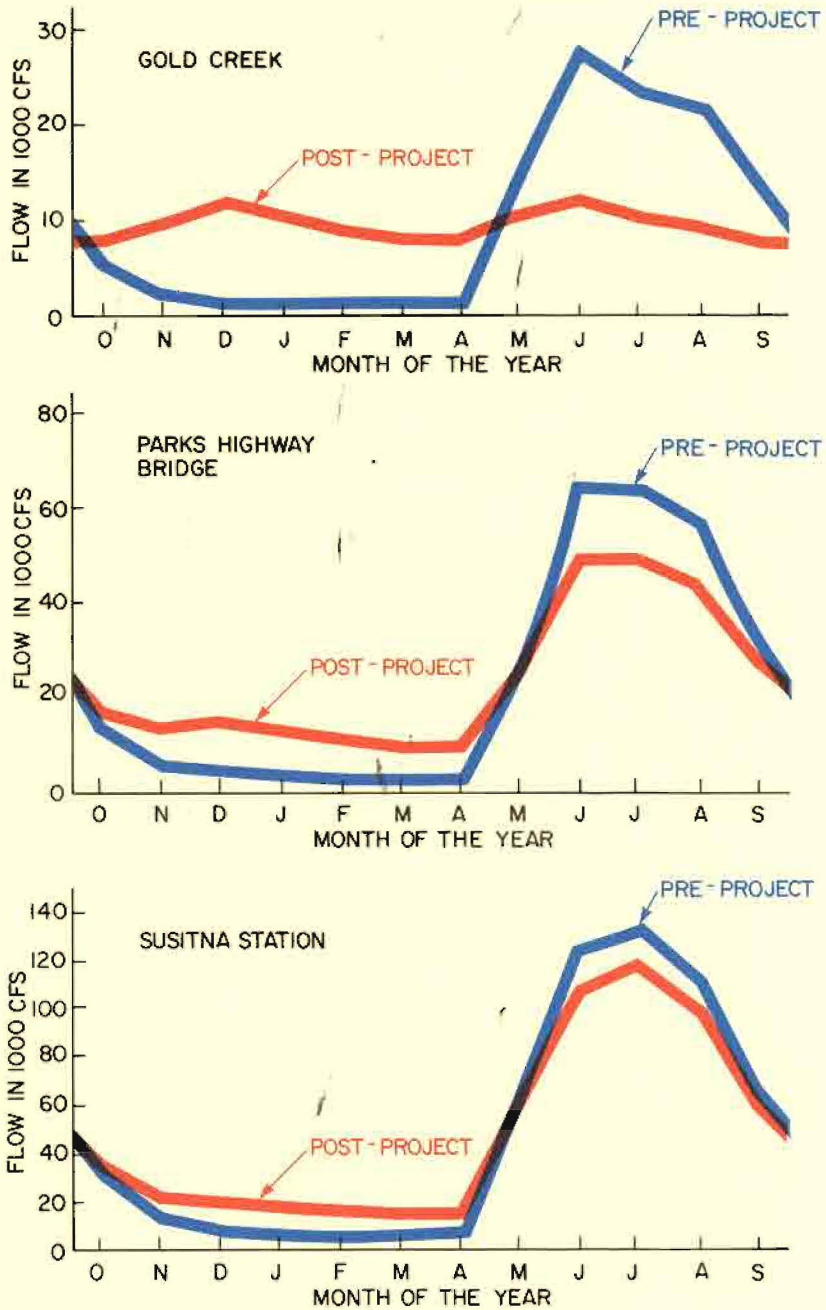
Operating Constraints

The extent of the concentration of Railbelt generation once Susitna has been built requires that special attention be paid to system reliability. To this end, four major categories of operational reliability criteria were applied in generation planning and project scoping: (1) total system loss of load probability must be less than one day in ten years, (2) a single contingency situation (e.g., loss of a single generating unit or a single transmission line) must be met without overloading remaining system components; a double contingency situation should be handled within emergency ratings of surviving system components for the probable duration of the outage, (3) provisions must be made for maintaining system stability and voltage regulation through a broad range of likely incidents, and (4) in the event of catastrophic loss (e.g. all transmission lines on a single right of way), rapid restoration of supply must be possible. A risk analysis of the proposed, transmission system confirmed that these criteria will be satisfied.

In addition to meeting technical criteria, project operation must also accommodate vagaries of nature (e.g., a year of unusually low flow conditions), a variety of important environmental constraints (e.g., downstream water quality and quantity), the performance characteristics of generating units (e.g., rough operation at less than 50 percent of maximum output for any single turbine-generator represents an equipment constraint), and geotechnical concerns (e.g., reservoir slope stability problems can be exacerbated by extreme drawdown and filling limits).

A mathematical model of the reservoir was used to evaluate the optimum method of operating the Susitna reservoirs and power plants to meet these criteria; from this it is estimated that average annual energy output of 3540 GWh at Watana alone and 6790 GWh for the total project can be achieved. Firm energy, corresponding to a low flow sequence expected to occur only once in 70 years, is about 5400 GWh per year.

AVERAGE ANNUAL ENERGY WILL BE 3450 GWh FOR WATANA ALONE AND 6790 GWh FOR THE TOTAL PROJECT.



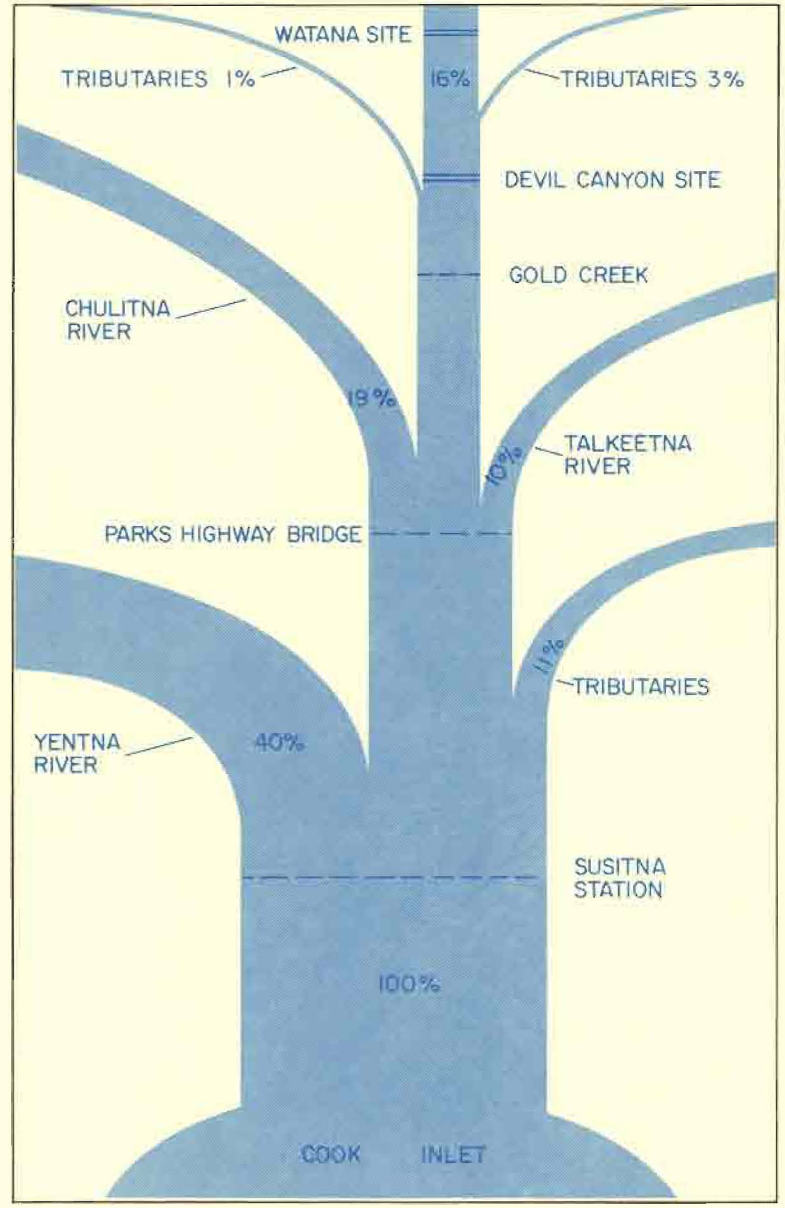


PLATE 15 **SUSITNA RIVER FLOWS**

Reservoir Considerations

A particularly critical period for effective project implementation occurs during impoundment of the Watana reservoir. Based upon meeting minimum post-project flow requirements in critical months for river maintenance and fisheries needs, about 2-1/2 years of average stream flow is required to fill the reservoir. Filling will commence after dam construction proceeds to a point where impoundment concurrent with continued construction can be accommodated even if a flood with a 100-year return frequency is realized during the filling operation. Once Watana reservoir is operational, later impoundment in the smaller Devil Canyon reservoir can be accomplished with relative ease.

Downstream Flows

Plate 15 provides a hydrograph which relates average flows under natural conditions with those which would normally be provided after the project is completed. Below the confluences with major tributaries of the Susitna River, differences between pre- and post-project flow conditions will be less pronounced, as the entire upper basin contributes less than 20 percent of the total discharge into Cook Inlet.

Reservoir Induced Seismicity

After the reservoirs are filled and particularly during the early years of project operation, some potential exists for reservoir induced seismicity (RIS). Earthquakes which would occur at some point in time under natural states of stress may be triggered by the increased weight of water in a new reservoir or by lubrication and hydraulic action upon highly stressed rock. Based upon mathematical models and data collected during the feasibility study, it is estimated that there is a 90-percent probability of an RIS event if both reservoirs are considered as a single hydrologic regime. The maximum magnitude of such an earthquake is estimated to be 6.0 on the Richter scale, which is within the range of extreme seismic events which the dams are designed to withstand. This maximum magnitude is no greater than that which could be produced under natural conditions if the project is never constructed.

How about post construction winter flow?

IT WILL TAKE 2-1/2 YEARS TO FILL THE WATANA RESERVOIR.

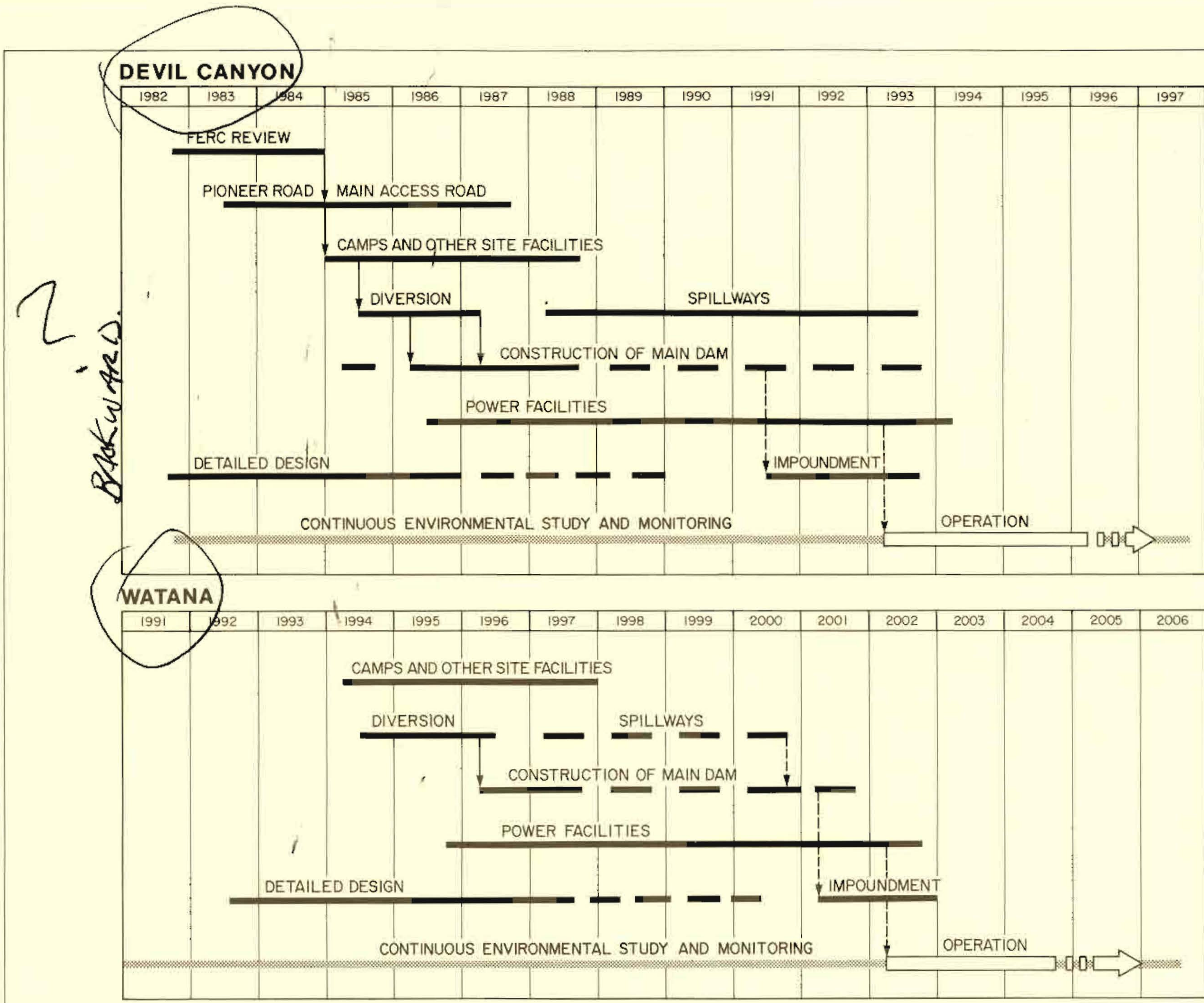


PLATE 16 **PROJECT SCHEDULE**

CONSTRUCTION 7

Because generation planning studies indicated that capacity must be added to the Railbelt system in the early 1990s, construction planning for the proposed Susitna project has been based upon meeting a 1993 power-on-line date. Plate 16 provides a broad schedule of activities which must take place if the Susitna project is to assist in meeting perceived needs implicit in the mid-range forecasts.

The Licensing Period

Should the State of Alaska decide to proceed with the project, a license application will be submitted to the Federal Energy Regulatory Commission (FERC) on September 30, 1982. Given the large size of the project and the inevitable changes its construction would cause, it may be anticipated that concerned agencies, organizations, and individuals will avail themselves of the opportunity to be heard. Thus, a period of 27 months has been set aside to accommodate license processing. Commencing in mid-1983 and concurrent with this processing period, construction of a limited access pioneer road is planned. Necessary permits for this activity will be submitted by September 1982.

Detailed design and the preparation of initial construction bid packages will also proceed during the license processing period. Important field investigations, particularly in the environmental and geotechnical areas, will continue.

Post-License Activities

Upon award of the FERC license, bids will be solicited for required early construction activities and for equipment with long lead times. The pioneer road will facilitate the transportation of equipment and camp modules to the Watana site so that camp and diversion facilities can be developed while construction of the main access road proceeds.

By mid-1985, work will commence on the first diversion tunnel at Watana. All diversion facilities, including cofferdams, will be operable in the spring of 1987. Thereafter, major construction activities for various project features will generally proceed in parallel. Reservoir impoundment will begin after breakup in 1991 and as soon as the main dam elevation is high enough to safely permit it.

The construction schedule for Devil Canyon is less critical, since under the mid-range forecast, power is not needed there until nearly a decade later than at Watana.

NO WAY Due to FERC And BLM

> **SHOULD THE STATE OF ALASKA DECIDE TO PROCEED WITH THE PROJECT, A LICENSE APPLICATION WILL BE SUBMITTED TO THE FEDERAL ENERGY REGULATORY COMMISSION ON SEPTEMBER 30, 1982.**

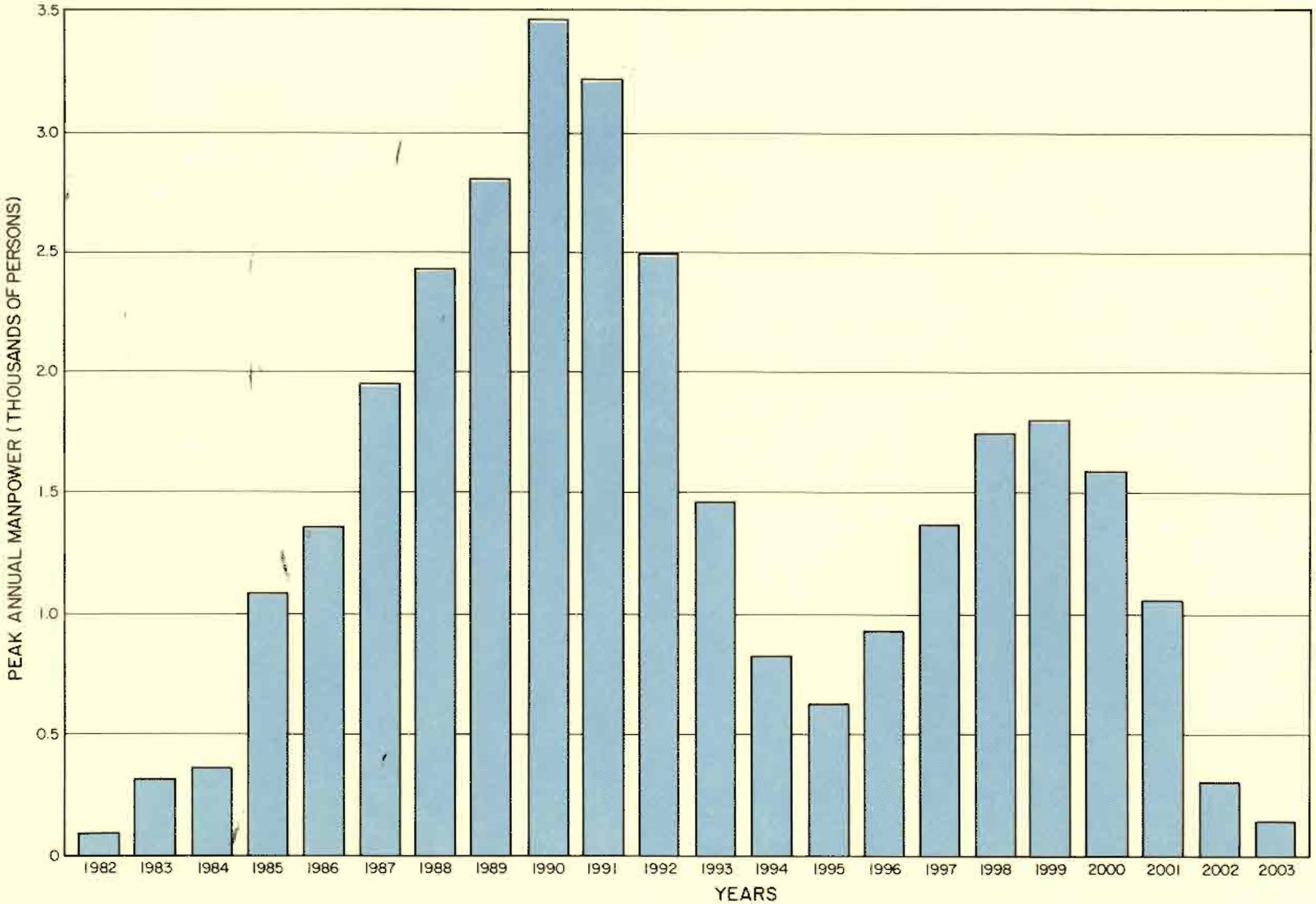


PLATE 17 **WORK FORCE**

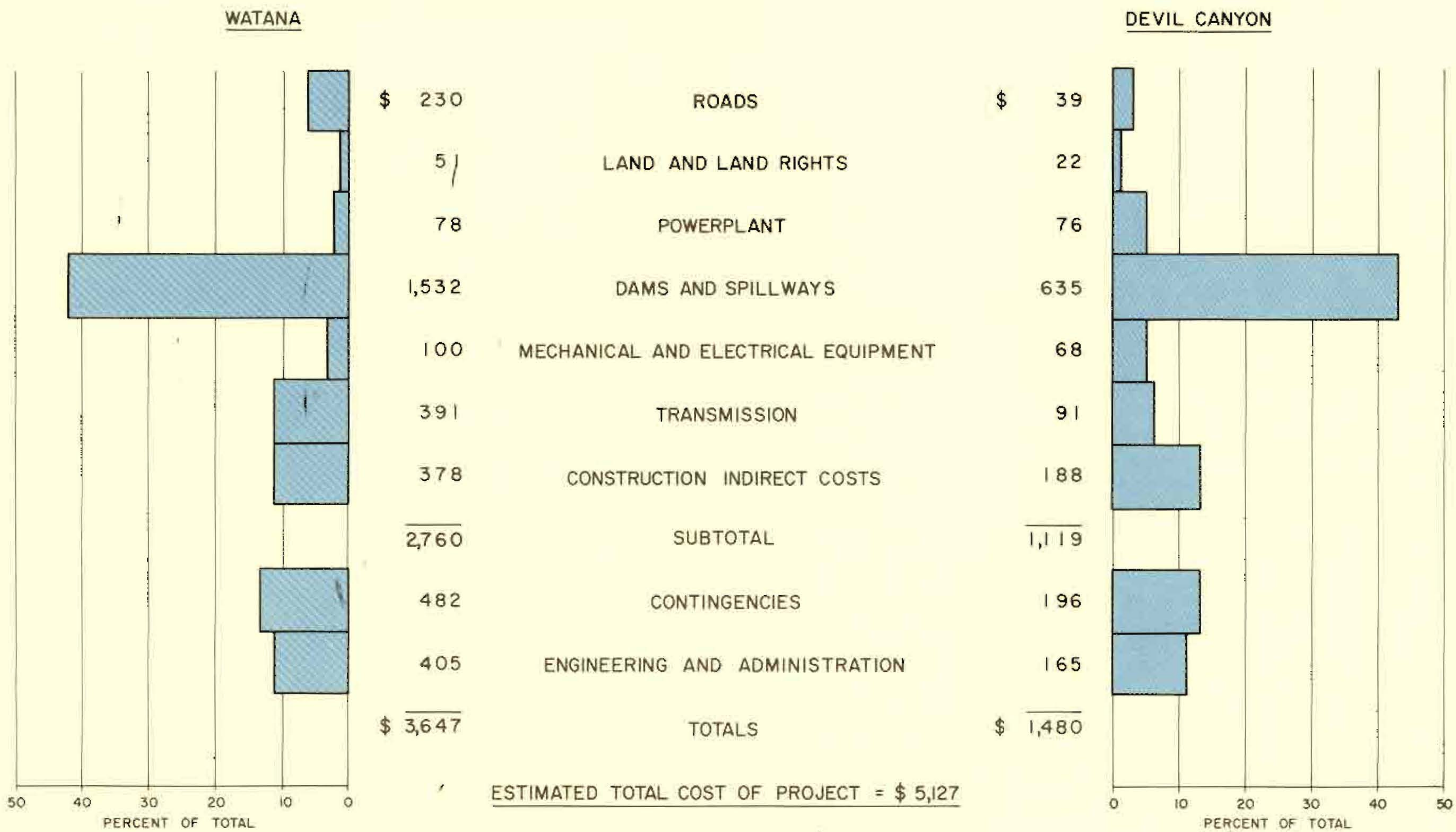
Risks

Although the project scheduling has taken into account historical data for normal efficiency and productivity in northern regions and allowances have been made for a range of possible adverse conditions, it is nonetheless true that important uncertainties remain. A schedule risk analysis was conducted to account for unusual extremes in nature, labor and material, and other variables. This indicates that while there is a 65-percent chance that the Watana project will be completed on or before the scheduled date, there is about a 10-percent chance that the power-on-line date will be delayed by two years or longer when important regulatory risks are accounted for (especially the possibility of delays in FERC licensing). Risks are further discussed in Section 8.

Manpower

Employment opportunities will be significant during construction of the Susitna project. A gradual increase in the work force will lead to an average requirement of about 1,450 persons between 1985 and 2000, and a peak of about 3,500 in 1990. Plate 17 plots manpower needs during the construction period of both projects.

EMPLOYMENT OPPORTUNITIES WILL BE SIGNIFICANT DURING CONSTRUCTION OF THE SUSITNA PROJECT.



ALL COSTS IN MILLIONS (JANUARY 1982 DOLLARS)

What About Mitigation Costs?

PLATE 18 ESTIMATE OF COST

Capital Cost Estimate

In terms of January 1982 dollars, the cost estimate of the Susitna development, including a 17.5 percent contingency and all overhead costs, but exclusive of allowance for funds used during construction, is about $5.1 billion dollars. Plate 18 summarizes major accounts for the Watana and Devil Canyon projects.

Preparation of the project estimate took into account detailed Alaska-specific data and historical experience, vendor quotations, construction methodology and feasibility, seasonal influences on productivity, and a variety of other factors. Allowances of about $150 million are included for important mitigation features integral to design (e.g., multi-level intake structure, outlet facility valves) or appropriate for aesthetic and socioeconomic considerations (e.g., restoration of disturbed areas, self-contained camp facilities).

Assumptions were generally conservative and the total project cost estimate is on the order of 50 percent higher than the January 1982 dollar value of the most recent estimate by the U.S. Army Corps of Engineers for a similar development of the upper Susitna basin.

Cost and Schedule Risks

Extreme floods or major earthquakes can lead to serious cost consequences if they occur during construction, although the project is designed to safely withstand such events after it is completed. Geotechnical investigations to date have included an unusually extensive drilling program for feasibility determination, but excavation during construction may yet reveal unfavorable and unanticipated conditions for which expensive remedial measures must be applied.

A risk analysis was conducted to determine the confidence level of the estimate as well as to define the probability of exposure to serious overruns. Up to 10 possible magnitudes for each of 21 different risks were considered, and probabilities were associated with each. Estimates were made of the conditional probabilities of various damage levels if any single risk magnitude were to be realized; and minimum, modal, and maximum values were assigned to the cost and schedule implications of appropriate responses. In addition to considering unusual and unexpected possibilities, the risk analysis also took into account historical variance between initial estimates and actual costs on various completed water resources projects.

PREPARATION OF THE PROJECT ESTIMATE TOOK INTO ACCOUNT DETAILED ALASKA-SPECIFIC DATA...

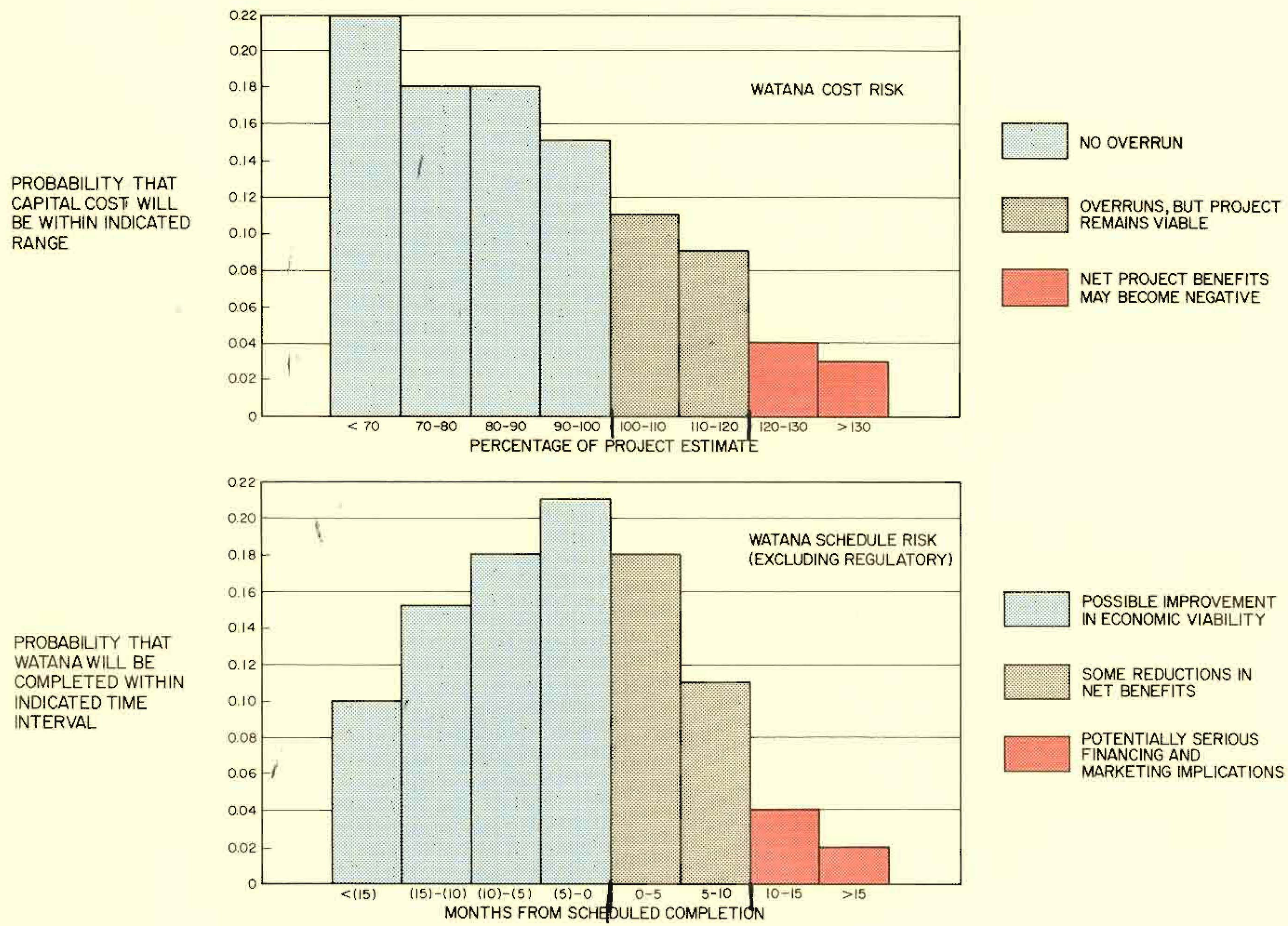


PLATE 19 **RISK DATA**

Probability distributions for selected intervals of possible cost and schedule variations are presented on Plate 19. As may be seen from the cost risk histogram, the probability that the project will be completed at a total cost between 90 percent and 100 percent of the estimate is about 0.15. A probability of 0.73 (73 percent confidence level) that the actual cost (in January 1982 dollars) will not exceed the project estimate can be determined by adding individual probabilities for each interval.

There is a 7-percent chance that the proposed Susitna development will experience overruns so great that the base case thermal alternative would be favorable.

The second histogram on Plate 19 indicates that there is about a 6-percent chance that delays other than those caused by regulatory matters will be long enough to cause serious financing and marketing implications.

In short, the estimated cost and schedule are likely to be achieved, although a not insignificant exposure remains.

Operation and Maintenance

As is characteristic of most new hydroelectric developments, the capital cost of the Susitna project per unit of installed capacity is much greater than that for conventional thermal plants. To the extent that net benefits are demonstrated for Susitna, they are largely derived from avoiding escalating fuel costs which form a large portion of the annual operating costs in the thermal case.

When the Susitna project is fully operational, a central maintenance staff and an operating staff, together with appropriate support personnel, will be located at the permanent townsite. Power plants at both dams will be controlled from the Susitna Area Control Center at Watana. In January 1982 dollars, the annual operating and maintenance costs will be $10 million for the first stage Watana project and $15.2 million for the complete development. For operation of the project within the Railbelt system, a Central Dispatch Control Center is planned near Willow.

POWER PLANTS AT BOTH DAMS WILL BE CONTROLLED FROM THE SUSITNA AREA CONTROL CENTER AT WATANA.

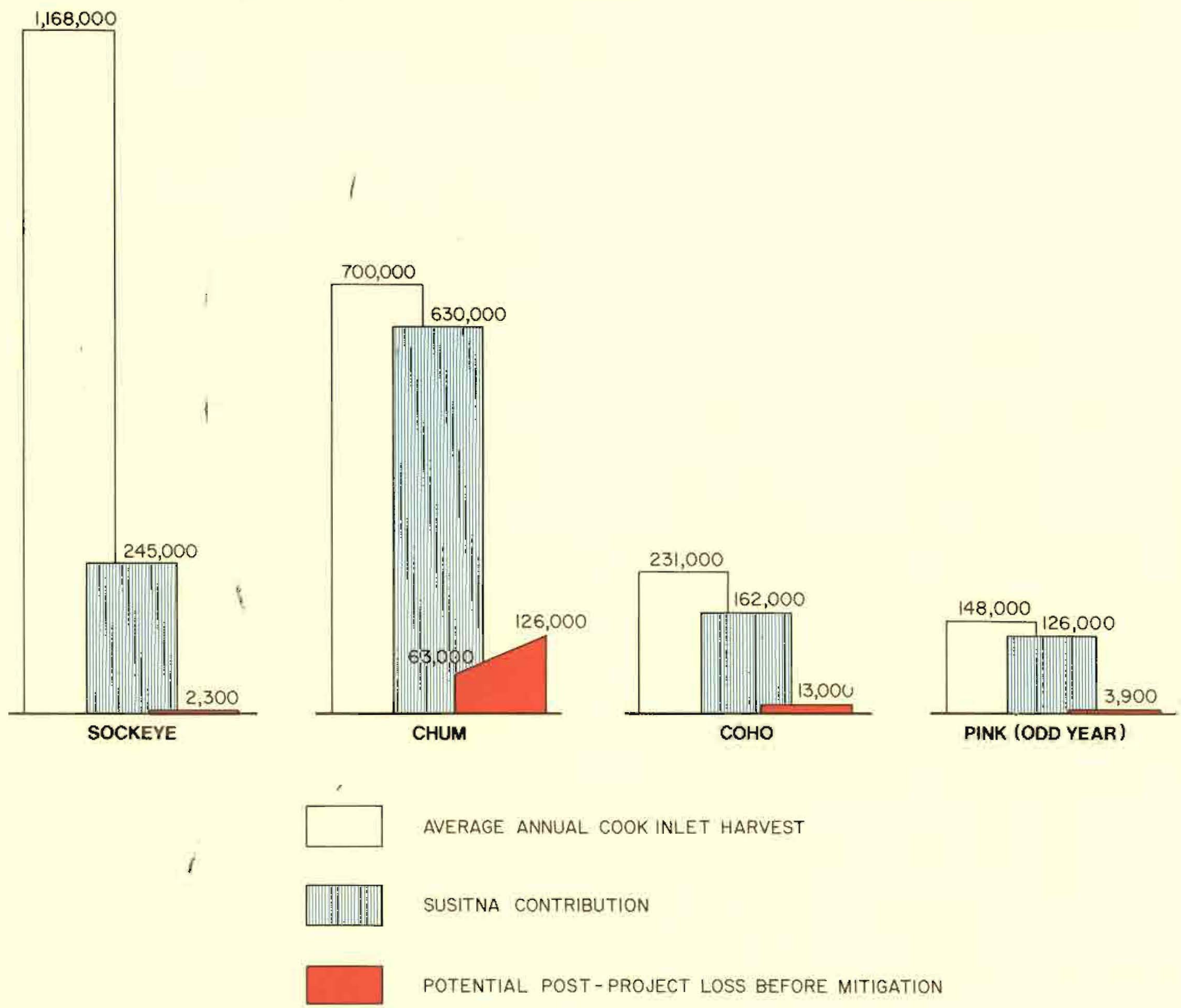


PLATE 20 **SALMON DISTRIBUTION IN THE SUSITNA**

ENVIRONMENTAL ISSUES

Environmental issues are addressed initially in this section in the context of the proposed Susitna development. Potential impacts associated with the non-Susitna plan are summarized in the final portion.

Fisheries

The Susitna River is a major contributor to Cook Inlet fisheries. More than half of the combined Cook Inlet total of chum, sockeye, coho and pink salmon return to the Susitna to spawn. Resident fish species abound as well in the basin. The mainstem provides a migratory corridor and most of the spawning habitat is located within tributaries, side channels and sloughs. Plate 20 illustrates estimated migratory distributions for important anadromous fish.

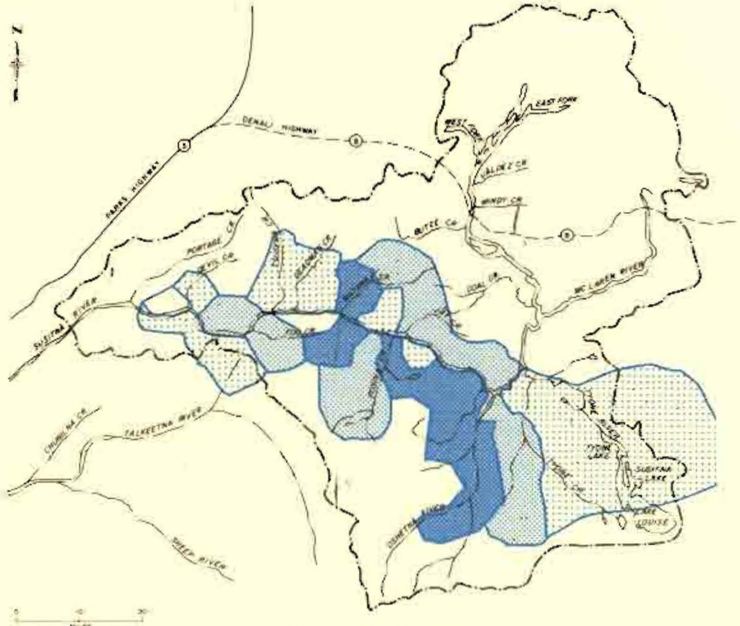
If the Susitna project is constructed, the principal fishery impacts will be measured upstream of the confluence of the Talkeetna River and the Susitna mainstem. In the absence of any mitigation efforts, the greatly altered post-project flow regime and warmer water temperatures in winter could result in a reduction of 63,000 to 126,000 chum from the current long-term average annual Cook Inlet harvest of 700,000. There would also be a decrease of 2,300 sockeye from an annual harvest of 1,168,000, and other losses as shown on Plate 20. In any single year, relatively large differences from these estimated long-term averages can occur. In 1981, for example, chum losses would have been 68,000 and sockeye 14,000.

Mitigation measures incorporated into project design include the effective removal of nitrogen supersaturation as a contributor to fish mortality and provisions for some water temperature control, as earlier described in Section 5. Other mitigation plans under consideration include modification of operating procedures to increase downstream flows during critical times, streambed modification to compensate for lost spawning habitat (though the effectiveness of such a measure is by no means certain — homing problems could ensue), and construction of a hatchery to replace losses.

Because of the natural barrier to migration near Devil Canyon, the principal direct impacts of reservoir impoundment will be felt only by resident fish populations. Some loss of spawning areas will be compensated by an increase in overwintering habitat and the reservoirs may provide the habitat necessary for the existing population of resident fisheries.

The ultimate objective of all the various mitigation measures is to achieve no net loss. Potential losses need not occur if proposed artificial measures to maintain the fishery resource are taken.

MITIGATION MEASURES HAVE BEEN INCORPORATED INTO PROJECT DESIGN...



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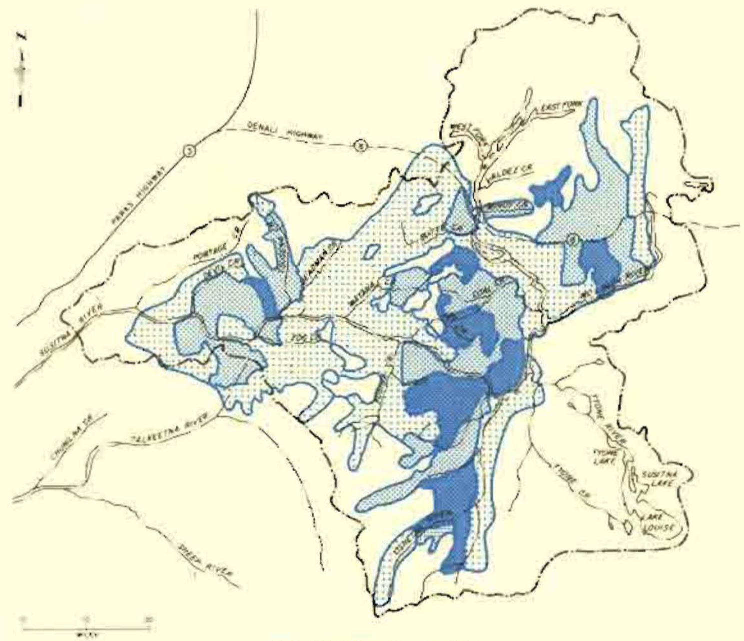


NOVEMBER 1980

LOW DENSITY

MEDIUM DENSITY

HIGH DENSITY

PLATE 21 **MOOSE DISTRIBUTION**

Wildlife Resources

The principal species of big game in the proposed project area are moose, caribou, wolf, wolverine, bear and dall sheep.

Plate 21 provides relative distributions of moose observed during the field investigation program. In addition to direct loss of inundated moose habitat and displacement of home ranges within the reservoir area, some reduction in downstream browse may occur as altered flow regimes affect vegetative succession. Habitat management is the principal mitigation measure being explored to maintain the moose population. Controlled burning to stimulate browse growth and reclamation of areas of disturbance are typical examples of habitat management being considered.

Although not recently used, an important historical migration route for caribou will be intersected by reservoir impoundment. Mud flats and shore line ice conditions could impede caribou migration despite their excellent swimming capability. Monitoring spring migration to locate calving areas and protection of calving grounds from human intrusion during the calving period are proposed. Clearing and removal of trees from the reservoirs is also proposed, to prevent mortalities which may be caused by floating debris.

Black bear prefer the forest habitat which lies within the impoundment zone. Nine known dens in the Watana reservoir and one in Devil Canyon will be flooded. Reductions in black bear population are likely if the project proceeds. Lesser losses will be suffered by brown bear as a result of reductions in seasonal foraging areas, though no known dens will be flooded. Restrictions will be imposed to reduce human-caused disturbances, and maintenance of a healthy moose population will aid in providing a food source for bears.

The Watana dall sheep herd uses a mineral lick along Jay Creek. Partial inundation of this lick will occur, and in the event that use by the herd is discontinued, an artificial lick with similar chemical composition will be established.

Furbearers will suffer some habitat loss and increased trapping and hunting pressure can be expected. Measures have been included in project planning to limit human access and to create common corridors for transmission and ground transportation. Hunting and trapping regulations will be enforced.

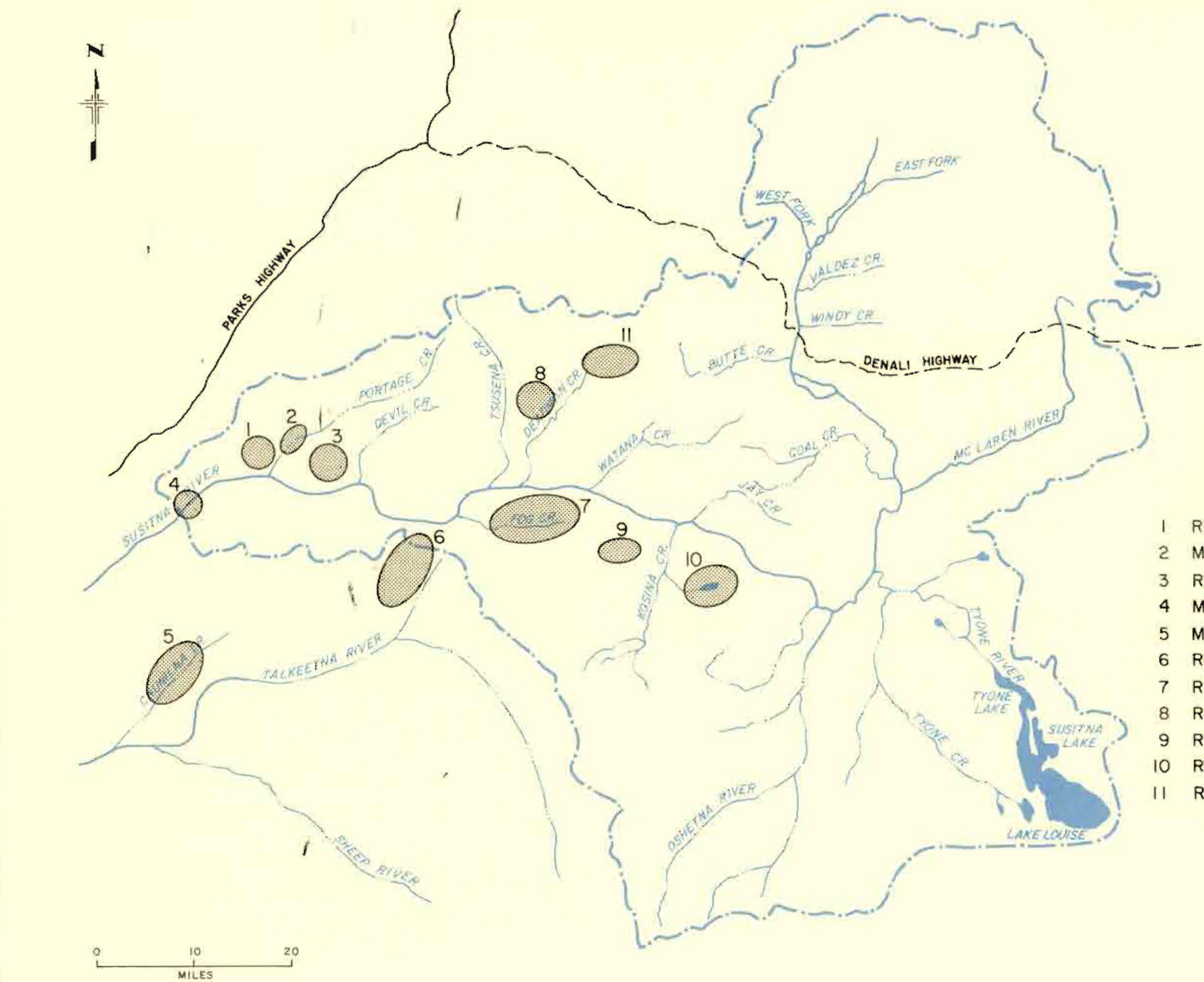
Active and inactive nest sites for golden eagle, bald eagle, and raven lie within the proposed reservoir area. Even so, creation of two large impoundments may result in an increased eagle population in the upper basin. Measures will be taken to preserve clumps of tall spruce trees to encourage nesting and the possibility of and need for constructing artificial nests will be explored.

No endangered species (the bald eagle is not endangered in Alaska) have been identified in the project area.

Historic and Archeological Resources

Archeological sites representing human occupation during the last 10,000 years and historic cabins built in the 1920s were located during the field investigation program. Mitigation will be accomplished through avoidance, preservation, and where appropriate, excavation and removal of artifacts to museums.

NO ENDANGERED SPECIES . . . HAVE BEEN IDENTIFIED IN THE PROJECT AREA.



	USE	INTENSITY
1	RECREATION	MEDIUM
2	MINING	MEDIUM
3	RECREATION	MEDIUM
4	MINING/RESID.	HIGH
5	MINING	HIGH
6	REC./RESID.	HIGH
7	RECREATION	HIGH
8	RECREATION	LOW
9	RECREATION	MEDIUM
10	RECREATION	MEDIUM
11	RECREATION	LOW

PLATE 22 LAND USE

Socioeconomics

The population of Alaska has increased steadily since the 1940s, with accelerated growth occuring in the 1970s. About 50 percent of the total is located in the greater Anchorage area, and the Railbelt as a whole contains 70 percent. Historical spurts have been occasioned by major project activities, generally followed by short-term decline or a leveling off. The Trans-Alaska Pipeline System provides the most recent example of this phenomenon. Increases in population during the past decade have been particularly pronounced in the Matanuska-Susitna Borough, within which the proposed dam sites are contained. The borough is more dependent on seasonal employment than large urban centers and has consistently had high unemployment rates.

As was indicated in section 8 of this report, significant employment opportunities will be generated over a period of 15 years if Susitna proceeds.

Demands for services (e.g. water supply, education) will increase in general by less than 5 percent above baseline conditions, particularly if much of the required work force is drawn, as planned, from within the state.

The greatest relative impacts are likely to be felt in Talkeetna and Trapper Creek, where housing shortages may occur and where proportionally greater numbers of visitors and would-be residents, particularly during the construction period, can be expected.

To mitigate adverse impacts on local communities, the proposed site facilities include construction camps and a permanent town site fully equipped with all amenities, thereby reducing the need for travel to and service from these areas. As the project proceeds, coordination will be maintained with local communities in order to maintain a proper balance between preservation of desired life style and local economic needs which project management may be able to satisfy.

Land Ownership and Use

Most land in the project area and directly south has been selected by Native corporations under provisions of the Alaska Native Claims Settlement Act. The U.S. Bureau of Land Management generally manages lands to the north.

Existing land use in the upper basin is typical for that of interior undeveloped Alaska (see Plate 22). Broad expanses of wilderness areas are present, access is severely restricted, and only a few man-made developments or structures are currently found. Early in the feasibility study period, a camp near the Watana dam site was erected on Native land to support field investigation activities. In the event that the Susitna project does not proceed, this camp facility may revert to Native ownership. If so, some further developments on Native land would probably occur.

If the project does proceed, only low-level recreational development is currently proposed. Camp grounds, picnic areas, boat launches, and hiking trails are planned, as are scenic overlooks.

While the creation of major dams and reservoirs will necessarily change the aesthetics, efforts were made in project planning to minimize visual impacts. Powerhouses will be underground, flow will be maintained in the short stretch between Devil Canyon dam and the tailrace portal downstream, borrow areas will be within the impoundment area where possible and will otherwise be restored or converted to ponds, and other similar measures will be taken.

MOST LAND IN THE PROJECT AREA AND DIRECTLY SOUTH HAS BEEN SELECTED BY NATIVE CORPORATIONS...

ALTERNATIVE GENERATING UNIT	POTENTIAL IMPACTS									
	AIR QUALITY	WATER QUALITY	TERRESTIAL ECOLOGY	AQUATIC/ MARINE ECOLOGY	NOISE, VISUAL & ODOR	HEALTH AND SAFETY	JOBS IN ALASKA	BOOM/ BUST EFFECTS	LAND-USE EFFECTS	SUSCEPTIBILITY TO INFLATION
ANCHORAGE-COOK INLET										
GAS TURBINE	Moderate	Minor	Minor	Minor	Moderate	Minor	Minor	Minor	Moderate	Significant
COAL-FIRED	Significant	Moderate	Moderate	Moderate	Significant	Moderate	Moderate	Moderate	Significant	Significant
FAIRBANKS-TANANA VALLEY										
GAS TURBINE	Moderate	Minor	Minor	Minor	Moderate	Minor	Minor	Minor	Moderate	Significant
COAL-FIRED	Significant	Moderate	Moderate	Moderate	Significant	Moderate	Significant	Moderate	Significant	Significant
HYDROELECTRIC										
CHAKACHAMNA	Minor	Moderate	Moderate	Moderate	Moderate	Minor	Significant	Significant	Significant	Minor

MINOR IMPACTS

MODERATE IMPACTS

SIGNIFICANT IMPACTS

PLATE 23 **BASE CASE IMPACTS**

Water Quality

In its natural state, the Susitna River is turbid after breakup. The estimated annual transport of suspended materials at the Gold Creek gaging station is 7.7 million tons. Winter flows are relatively free of sediment.

Sediment capture efficiencies for proposed reservoirs are estimated at 70 to 100 percent. In 100 years, the estimated sediment deposition will represent about 5 percent of the gross reservoir volume at Watana and about 14.2 percent at Devil Canyon. No reduction in energy production as a result of sedimentation is anticipated during the project life. As a result of sedimentation entrapment, flows downstream of Devil Canyon will be considerably less turbid in late spring, summer, and early fall. Winter flows will be more turbid than under natural conditions. Other water quality changes will occur, but no significantly adverse impacts are anticipated.

Non-Susitna Expansion

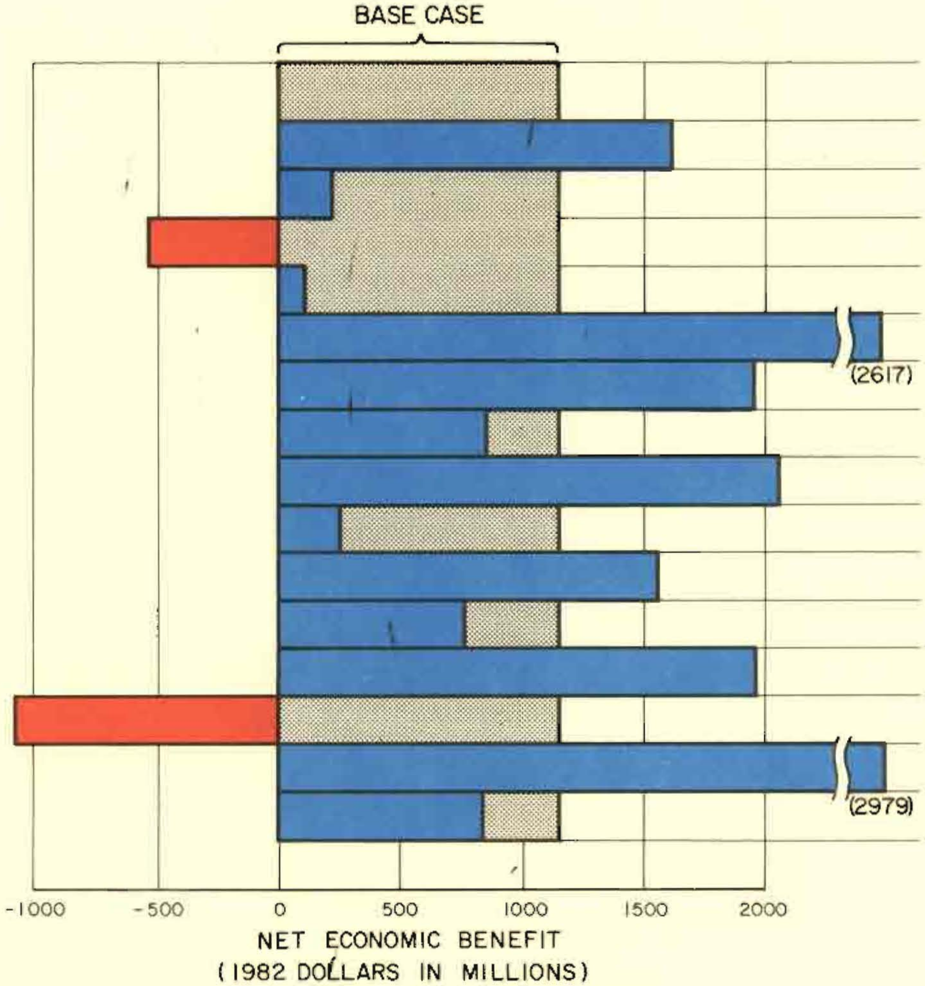
It was earlier noted that significant generating capacity must be added to the Railbelt system during the study period if the mid-range forecast is realized. If, instead of proceeding with Susitna, the base case representative thermal plan is followed, different types of environmental impacts can be expected. Plate 23 summarizes impacts as presented in the Battelle report for system additions common to both Battelle's Plan 1A and the representative thermal plan. Chakachamna appears on the summary because the economic effect of its inclusion was tested in the sensitivity analysis.

Coal-fired steam generating plants, the principal component of the representative non-Susitna plan, will be developed in open, well-ventilated sites as near as possible to available coal fields. Visual impacts will be significant since plumes from cooling towers and smokestacks will be seen for miles, particularly in winter months. Local air quality degradation will be inevitable. Relatively large land areas will be required to accommodate major plant components, stockpiles, and mining operations. Lesser, but nonetheless important impacts in other categories as shown on Plate 23 will occur.

Gas turbines would be environmentally superior to coal-fired plants, but new units of this type will serve primarily to satisfy peaking needs and to maintain system reliability criteria. Neither gas supply estimates nor cost expectations support long-term reliance on gas as the principal fuel for generation of electricity.

Construction of a hydroelectric plant at Chakachamna would introduce impacts generally of the types described in preceding paragraphs for the Susitna project. Studies to date by others on Chakachamna have not advanced sufficiently to make definitive estimates of potential fish losses, but initial indications are that they will be greater on a relative basis that those associated with the Susitna project.

IN 100 YEARS, THE ESTIMATED SEDIMENT DEPOSITION WILL REPRESENT ABOUT 5 PERCENT OF THE GROSS RESERVOIR VOLUME AT WATANA AND ABOUT 14.2 PERCENT AT DEVIL CANYON.



ELEMENT TESTED	BASE CASE VALUE
HIGH LOAD FORECAST (11,400 GWH IN 2010)	7,800 GWH IN 2010
LOW LOAD FORECAST (6,300 GWH IN 2010)	7,800 GWH IN 2010
5 % REAL DISCOUNT RATE	3 %
4 % REAL DISCOUNT RATE	3 %
2 % REAL DISCOUNT RATE	3 %
HIGH CAPITAL COST FOR ALTERNATIVE (20 % ABOVE ESTIMATE)	BATTELLE ESTIMATE
LOW CAPITAL COST FOR ALTERNATIVE (10 % BELOW ESTIMATE)	BATTELLE ESTIMATE
LOW SUSITNA CAPITAL COSTS (83 % OF ESTIMATE)	PROJECT ESTIMATE
HIGH SUSITNA CAPITAL COSTS (117 % OF ESTIMATE)	PROJECT ESTIMATE
ZERO CAPITAL COST ESCALATION	1.8 % / ANNUM
HIGH CAPITAL COST ESCALATION (3.6 % / ANNUM)	1.8 % / ANNUM
HIGH BASE COAL PRICE ($ 2.08 / MM BTU)	$ 1.43 / MM BTU
ZERO FUEL PRICE ESCALATION	2.6 % TO 2000 1.2 % TO 2010
HIGH FUEL PRICE ESCALATION (5 % TO 2000, 2.2 % TO 2010	2.6 % TO 2000 1.2 % TO 2010
CHAKACHAMNA ALTERNATIVE	ALL THERMAL PLAN

PLATE 24 **SENSITIVITY ANALYSIS**

ECONOMICS

In spite of the fact that some legislative support has been demonstrated for subsidies and grants for hydroelectric development, all economic analyses to identify plans and to determine net benefits were conducted on a common, non-subsidized basis. Thus, competing plans were tested on equal terms.

Net economic benefits were calculated by comparing the system-wide production costs of electricity with and without the Susitna project. The OGP model was employed for this purpose, and for the set of economic parameters considered most likely in the base case, the Susitna project was shown to have an advantage over the representative thermal plan of $1176 million (expressed as present worth in 1982 dollars of the difference in total costs of the two plans over an assumed 50-year operating period). A great deal of uncertainty was associated with the various parameters whose values contributed to this result, however. It was noted in Section 8, for example, that a range of possible Susitna capital costs must be contemplated, and earlier in Section 2 that demand can vary across a broad spectrum. Other parameters are far from firm.

Sensitivity Analysis

A sensitivity analysis was conducted to determine the extent to which a reasonably conceivable change in any single parameter would affect the outcome of the analysis. Results are presented on Plate 24.

The most sensitive parameter is clearly the assumed future escalation of fuel prices, particularly coal, over and above the underlying inflation rate. Simply stated, it would be an unwise economic decision to develop Susitna if long-term fuel price stability could be assured. High fuel price escalation in the future, on the other hand, would make Susitna increasingly attractive.

Varying the real (inflation adjusted) discount rate also demonstrates strong effects. The apparent "break even" discount rate is about 4.1 percent.

The Chakachamna project had not been included in the base case for reasons earlier noted in Section 3. If environmental issues can be resolved there and if the initial cost estimate is adhered to, a combination of the Chakachamna hydroelectric project and thermal generation additions would present a lower cost alternative than the all-thermal plan, but Susitna would continue to be favored.

Tests were also made to evaluate the economic effects of delays. A one year delay for the Watana project alone would reduce net benefits by $43 million. Delaying both Watana and Devil Canyon one year causes a reduction of $103 million. A two year delay for both yields a decrease of $168 million.

Not shown on Plate 24, but also worthy of consideration is the extent to which a decision not to proceed with the currently planned Bradley Lake Project would change net benefits. Such a scenario would make the non-Susitna plan more costly and would raise the net benefits of the Susitna plan from $1176 million to $1453 million.

. . . ALL ECONOMIC ANALYSES TO IDENTIFY OPTIMAL PLANS AND TO DETERMINE NET BENEFITS WERE CONDUCTED ON A COMMON, NON-SUBSIDIZED BASIS.

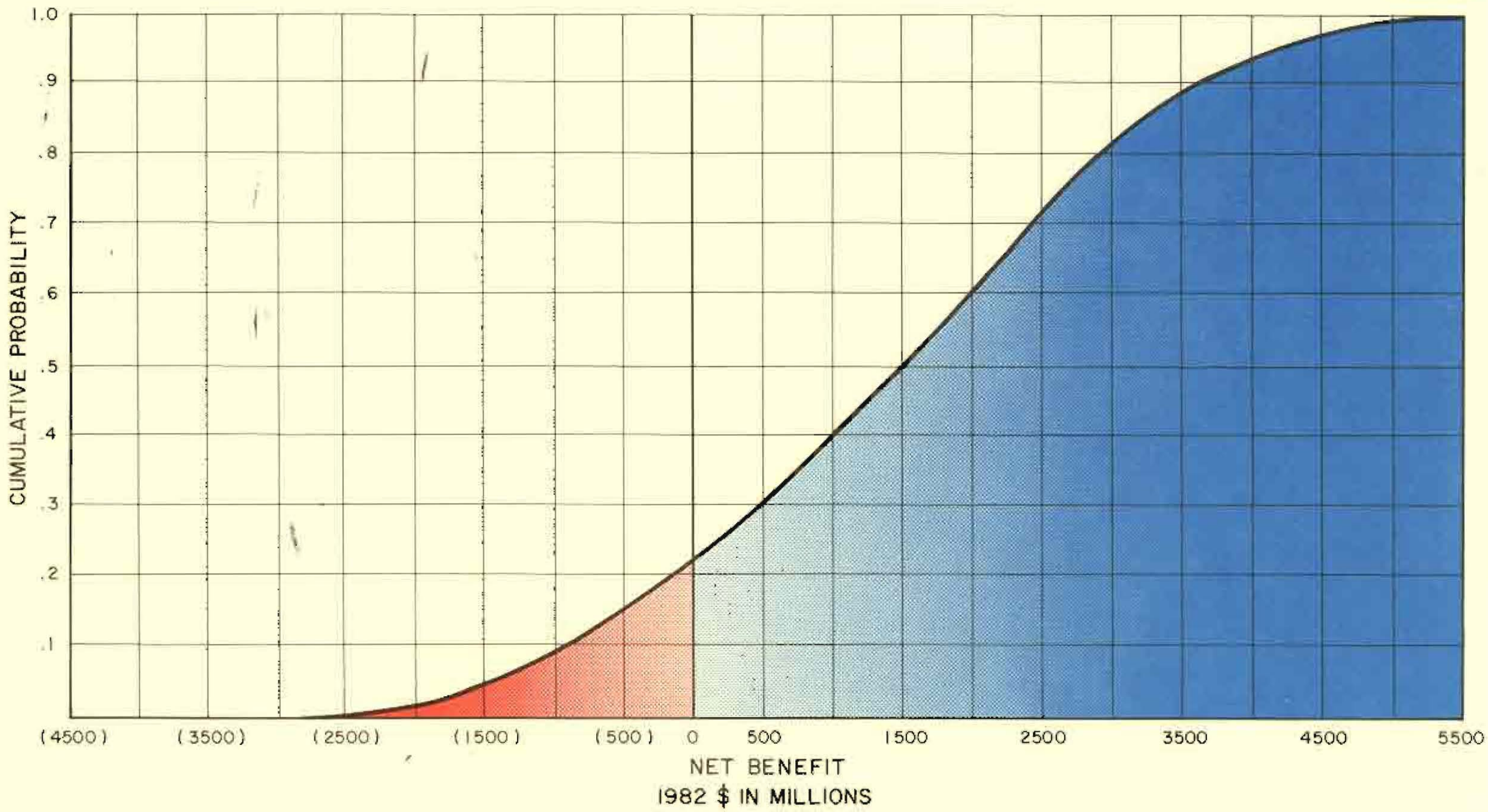


PLATE 25 **MULTI - VARIATE SENSITIVITY**

"Multi-Variate" Analysis

Given the uncertainties involved in each of the parameters subjected to sensitivity tests, there is no reason to believe that only one will ultimately vary from the assumed center-point values. To test the effect of multiple variations, a "decision tree" was constructed and the probability of occurrence was assigned to each of three possible values for the four most sensitive parameters. OGP runs were made to determine long-term present worth costs of each possible combination of load forecast, Susitna capital cost, alternative capital cost, and fuel cost escalation. Discount rates were not included in this analysis because their determination is largely a matter of policy.

Based on this analysis, the cumulative probability that a particular net benefit will not be exceeded is plotted on Plate 25. As may be seen from that depiction, there is about a 23 percent chance that a decision to proceed with Susitna will result in negative or zero net benefits, and the maximum negative exposure is about $2.5 billion. Correspondingly, the chance that Susitna will produce positive benefits over a 50-year operating period is about 77 percent, with cost advantages as high as $5.5 billion.

Conservative Treatment

Certain features of the economic analysis probably introduced a measure of conservatism into the calculation of net benefits. The first and most significant such feature is the fact that constant production costs were assumed after 2010 in all cases tested. This assumption has the effect of excluding both real escalation in fuel prices after 2010 and the replacement costs of thermal plants which have a shorter operating life than hydroelectric facilities.

A second consideration has to do with load forecasts. For purposes of the economic analysis, no further growth was assumed after 2010. Thus, no benefit to Susitna accrues for available energy output of about 340 GWh which is not forecast to be required by the system by 2010. In addition, no cost penalties were assigned to thermal plants to account for possible future environmental legislation; finally, indications by the OGP model that a new thermal plant would be needed in 2011 if only a minor increase in load occurred thereafter were ignored.

It was earlier noted in Section 3 that important uncertainties exist with respect to economic development of the Beluga coal fields and the long term availability of Cook Inlet gas. Nonetheless, the economic analysis was conducted as if no such constraints were present.

CERTAIN FEATURES OF THE ECONOMIC ANALYSIS PROBABLY INTRODUCED A MEASURE OF CONSERVATISM INTO THE CALCULATION OF NET BENEFITS.

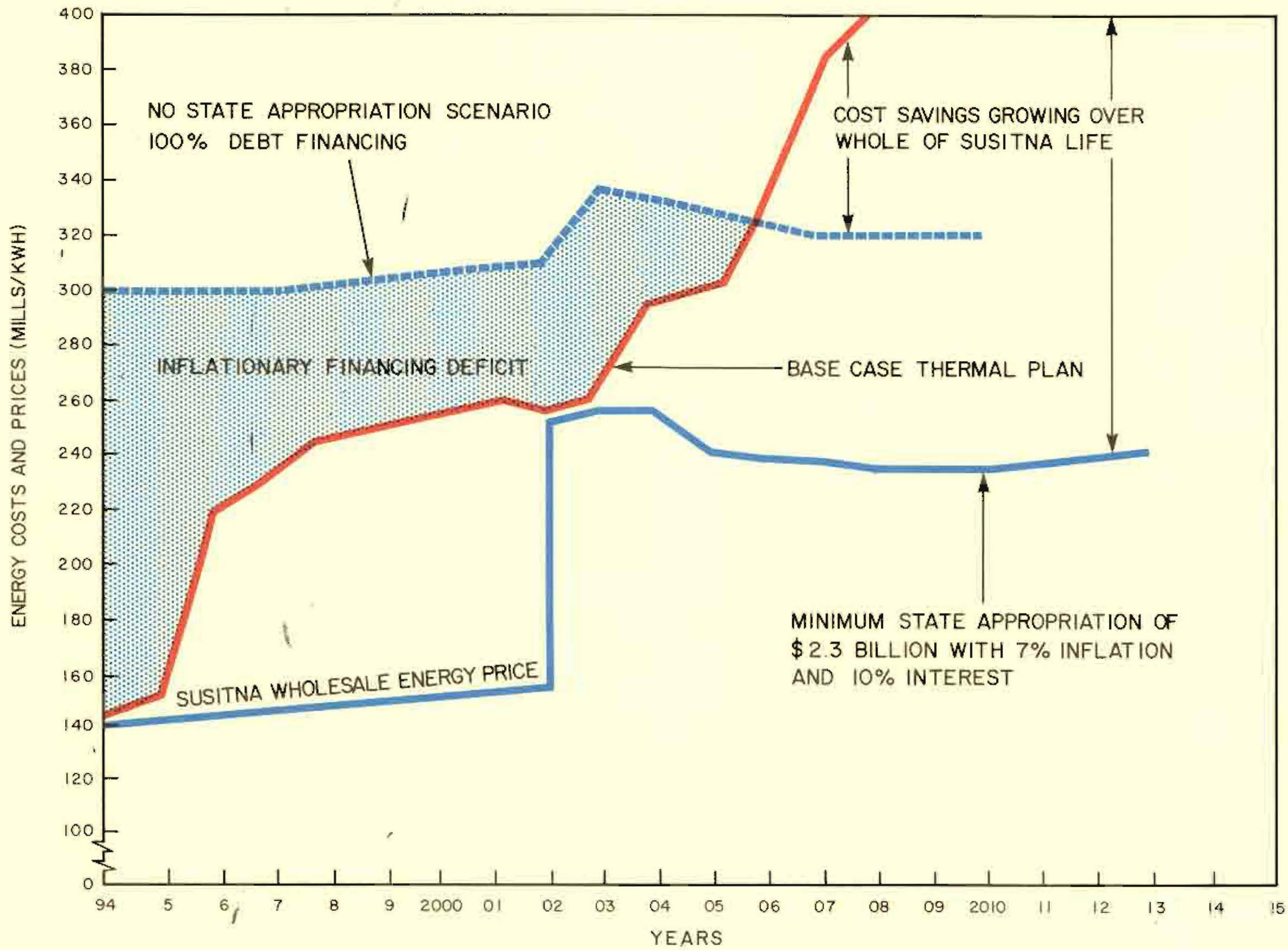


PLATE 26 ANNUAL COST COMPARISION

FINANCING AND MARKETING

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Having demonstrated, by the economic analysis described in the previous secton, that there is a high probability that development of the hydroelectric potential of the Susitna basin would provide significant cost advantages when compared to alternative means of meeting projected Railbelt power demands, further analyses were made of the financial aspects of the development program. These further analyses were aimed at determining whether the project could be financed in an inflationary economy and what impact various scenarios for state participation in funding would have on the ultimate cost to the consumer. The results of one such analysis are plotted in Plate 26.

The sharply rising red line on Plate 26 traces the unit energy costs associated with the representative all-thermal plan. The same curve had been presented earlier on Plate 5. The dashed curve lying above thermal plan costs in the early years of project operation is associated with a Susitna case with no state participation. It exhibits a characteristic which is common to many major capital-intensive projects. Simply stated, the Susitna Hydroelectric Project would be more costly to the consumer in its early years of operation, if no state participation is involved, than the thermal plan. After about a dozen years, rising thermal plan costs intersect those for Susitna. Thereafter, the Susitna plan looks increasingly more attractive and, over a 50-year economic life, it can be shown that Susitna would generate important cost savings — even without state funding participation. The project is expected to remain operational long after the 50-year life upon which economic and financial analyses were based. Once project debts are amortized, Susitna costs will drop dramatically.

The third curve, shown as the solid blue line on Plate 26, illustrates the case for which state participation is just enough to make the entry costs for Susitna comparable to those for the thermal plan, increasingly great savings being realized thereafter. Other financing variations were explored in the detailed feasibility report. It is anticipated that conventional financing will be used to provide required funding over and above whatever state participation is involved. State participation at the level indicated by the solid blue curve would provide an 11 percent return on investment.

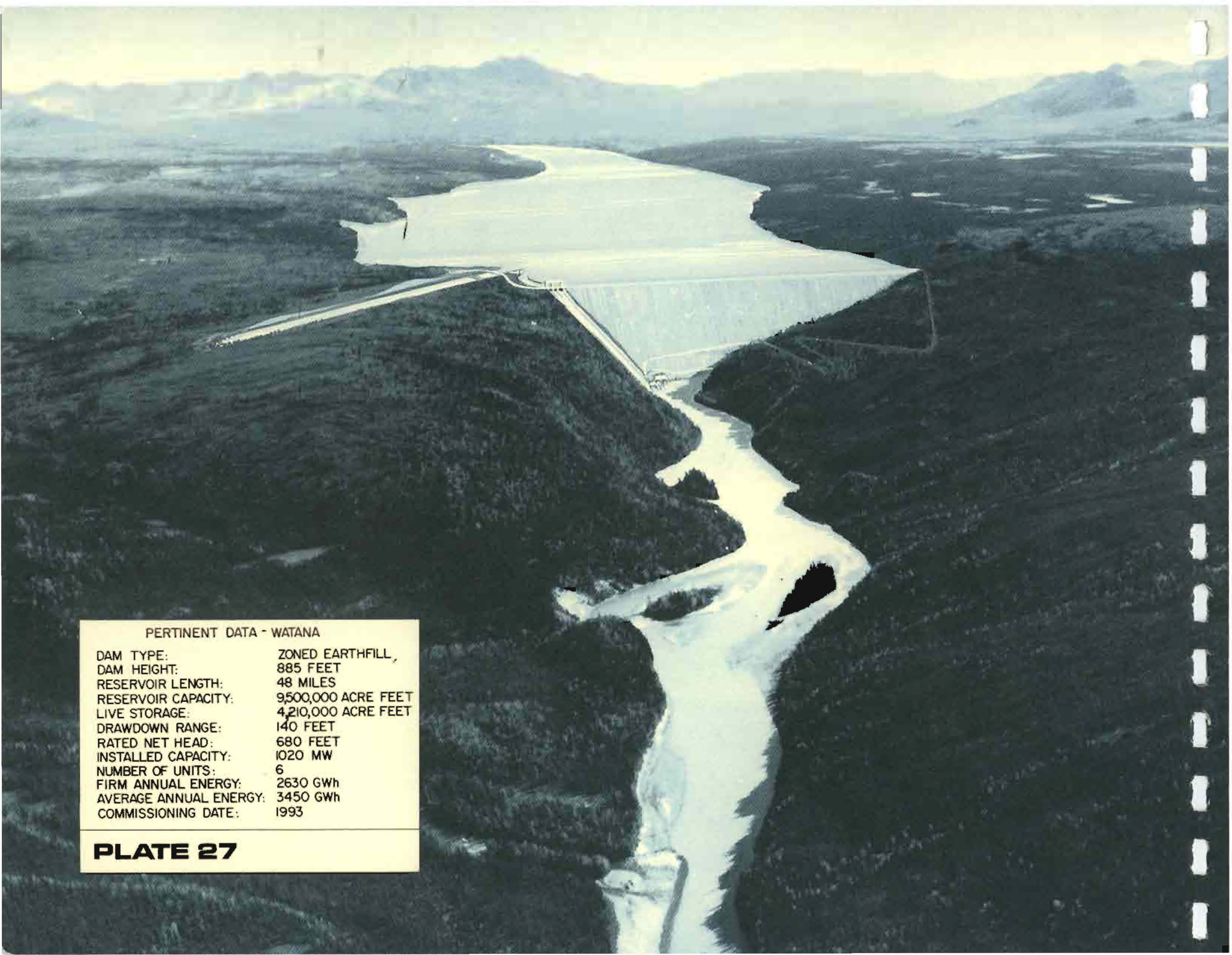
Financing Risks

Financial risks to the state and to consumers were analyzed, taking into account such factors as the risks of bond requirement overrun, inadequate debt service cover and others. The analysis suggests that there is a probability of 0.73 (73 percent confidence level) that savings to the Alaska consumer will be equal to or greater than those calculated.

Marketing Considerations

The Railbelt market area was earlier described in Section 2. In the absence of any plans to merge existing utilities into a central power authority, it was assumed that various utilities will enter into contracts for Susitna energy if it is seen as the lowest cost alternative available for meeting demand. Under the minimum state appropriation scenario, purchase of Susitna energy would be found preferable to installing and operating new thermal plants either to meet demand or to replace retiring units.

The relatively large capacity associated with each successive stage of the Susitna project will inevitably lead to periods during which more capacity is available to the system than prudent reserve criteria would otherwise require. As a result, it may be anticipated that those thermal units which are most costly to operate will be shut down temporarily until demand rises once again to the point that additional capacity is needed. During wet years, hydroelectric energy production in excess of estimated firm energy output will be available at virtually no incremental cost, and it will be used to displace higher cost energy from some thermal plants which may be operated only during years of low flow. In short, under the minimum state appropriation scenario, total system generation costs (and, therefore, costs to the consumer) will be less after various Susitna stages come on line even though a temporary surfeit of capacity may exist.



PERTINENT DATA - WATANA

DAM TYPE:	ZONED EARTHFILL
DAM HEIGHT:	885 FEET
RESERVOIR LENGTH:	48 MILES
RESERVOIR CAPACITY:	9,500,000 ACRE FEET
LIVE STORAGE:	4,210,000 ACRE FEET
DRAWDOWN RANGE:	140 FEET
RATED NET HEAD:	680 FEET
INSTALLED CAPACITY:	1020 MW
NUMBER OF UNITS:	6
FIRM ANNUAL ENERGY:	2630 GWh
AVERAGE ANNUAL ENERGY:	3450 GWh
COMMISSIONING DATE:	1993

PLATE 27

IMPLEMENTATION

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The essential conclusions of the detailed feasibility study are that the project is technically feasible and economically viable. The safety of the population in the vicinity of the project will not be impaired and the unavoidable impacts which this large project will cause on the environment will not be unduly severe and can be adequately mitigated. Financing of the project is also feasible with state assistance at acceptable risk to consumers in the Railbelt region.

In the event that the state decides to proceed with the project, a license application will be prepared and it will be filed with the Federal Energy Regulatory Commission by September 30, 1982.

The high level of activity associated with environmental studies will continue unabated throughout the licensing period, which is assumed to extend until December 1984, and into the construction period should this proceed. Technical field investigations will continue as well. Future environmental and engineering findings will influence detailed design.

Prior to submission of the license application, the Alaska Power Authority will accept competitive proposals for detailed engineering services from qualified firms and will select one or more organizations to continue the work after September 1982 when the contractual obligations of Acres American Incorporated will have been fulfilled.

Aside from the construction of a limited access pioneer road commencing in mid-1983, activities within the proposed project area will not cause irreversible change before award of a license and prior to a further decision by the state to construct the first stage Watana dam and associated facilities.

No major commitment of funds is necessary to support preparation of a license application since its content will largely be based upon studies completed to date. Continuation beyond that point will require an investment in excess of $50 million, including land costs, before the end of 1983 to support continuing investigations and the commencement of detailed design and pioneer road construction. Immediate action is necessary to ensure that required lands are available for this early construction activity. Options open to the Power Authority include purchase, lease, and land transfer options.

THE ESSENTIAL CONCLUSIONS ARE THAT THE PROJECT IS TECHNICALLY FEASIBLE AND ECONOMICALLY VIABLE. UNAVOIDABLE IMPACTS WILL NOT BE UNDULY SEVERE AND CAN BE ADEQUATELY MITIGATED.

PERTINENT DATA - DEVIL CANYON

DAM TYPE:	CONCRETE ARCH
DAM HEIGHT:	645 FEET
RESERVOIR LENGTH:	26 MILES
RESERVOIR CAPACITY:	1,092,000 ACRE FEET
LIVE STORAGE:	350,000 ACRE FEET
DRAWDOWN RANGE:	55 FEET
RATED NET HEAD:	575 FEET
INSTALLED CAPACITY:	600 MW
NUMBER OF UNITS:	4
FIRM ANNUAL ENERGY:	2770 GWh
AVERAGE ANNUAL ENERGY:	3340 GWh
COMMISSIONING DATE:	2002

PLATE 28

REFERENCES AND ACKNOWLEDGEMENTS

13

References

Information presented in this summary report is drawn from two principal sources, both of which have been distributed to libraries throughout the Railbelt:

(1) **Draft Susitna Hydroelectric Project Feasibility Report,** Acres American Incorporated, March 1982:

Volume 1 — Engineering and Economic Aspects
- Section 1: Introduction
- Section 2: Summary
- Section 3: Scope of Work
- Section 4: Previous Studies
- Section 5: Railbelt Load Forecasts
- Section 6: Railbelt System and Future Power Generation Options
- Section 7: Susitna Basin
- Section 8: Susitna Basin Development Selection
- Section 9: Selection of Watana General Arrangement
- Section 10: Selection of Devil Canyon General Arrangement
- Section 11: Selection of Main Access Plans
- Section 12: Watana Development
- Section 13: Devil Canyon Development
- Section 14: Transmission Facilities
- Section 15: Project Operation
- Section 16: Estimates of Cost
- Section 17: Development Schedule
- Section 18: Economic and Financial Evaluation

Volume 2 — Environmental Aspects
- Section 1: General Description of the Locale
- Section 2: Water Use and Quality
- Section 3: Report on Fish, Wildlife, and Botanical Resources
- Section 4: Report on Historic and Archeological Resources
- Section 5: Report on Socioeconomic Impacts
- Section 6: Geology and Soils
- Section 7: Report on Recreational Resources
- Section 8: Report on Aesthetic Resources
- Section 9: Report on Land Use
- Section 10: Alternatives to the Susitna Project
- Section 11: List of Literature

Volume 3 — Plates

Volumes 4 through 8 — Appendices

(2) **Comment Draft Railbelt Electric Power Alternatives Study: Evaluation of Railbelt Electric Energy Plans,** Battelle Pacific Northwest Laboratories, February 1982.

Acknowledgements

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Institute for Social and Economic Research, University of Alaska
Alaska Department of Fish and Game

Cooperation and assistance from resource agency representatives who served on the Steering Committee is gratefully acknowledged, as is the extraordinary effort of the Public Participation staff of the Alaska Power Authority.

Rigorous professional review of all major aspects of the proposed Susitna development was accomplished by the External Review Panel which reported to the Alaska Power Authority, and by a second Review Panel and numerous consultants who assisted the Acres' team throughout the course of the work. The diligence and skill of these eminent experts has been important to the successful identification and resolution of problems and to the development of optimal plans.

Space limitations preclude the mention by name of the many others whose interest, support, and healthy criticism have been invaluable, but their selfless efforts are sincerely appreciated.

Finally, the expert management and guidance provided by the Executive Director and the staff of the Alaska Power Authority and the unusual professionalism they have displayed throughout the study period are particularly worthy of note.

Your comments on the feasibility report are invited. To be considered in preparation of the final report and in the Power Authority's pending decision on the filing of a license application, comments will have to be received by April 21, 1982. They should be addressed to: Eric P. Yould, Executive Director, Alaska Power Authority, 334 W. 5th Avenue, Anchorage, Alaska 99501.

Prepared by:
Acres American Incorporated
for
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