ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

NOTES ON STUDY STATUS
FOR SUBMISSION TO FERC

APRIL 1981

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1. EXTRACTS FROM PROJECT OVERVIEW REPORT

The Project Overview Report is intended to be a summary of the status of feasibility studies undertaken during 1980. This report is reproduced on the following pages.

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PROJECT OVERVIEW

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PROJECT OVERVIEW

SUSITNA HYDROELECTRIC PROJECT

1 - INTRODUCTION

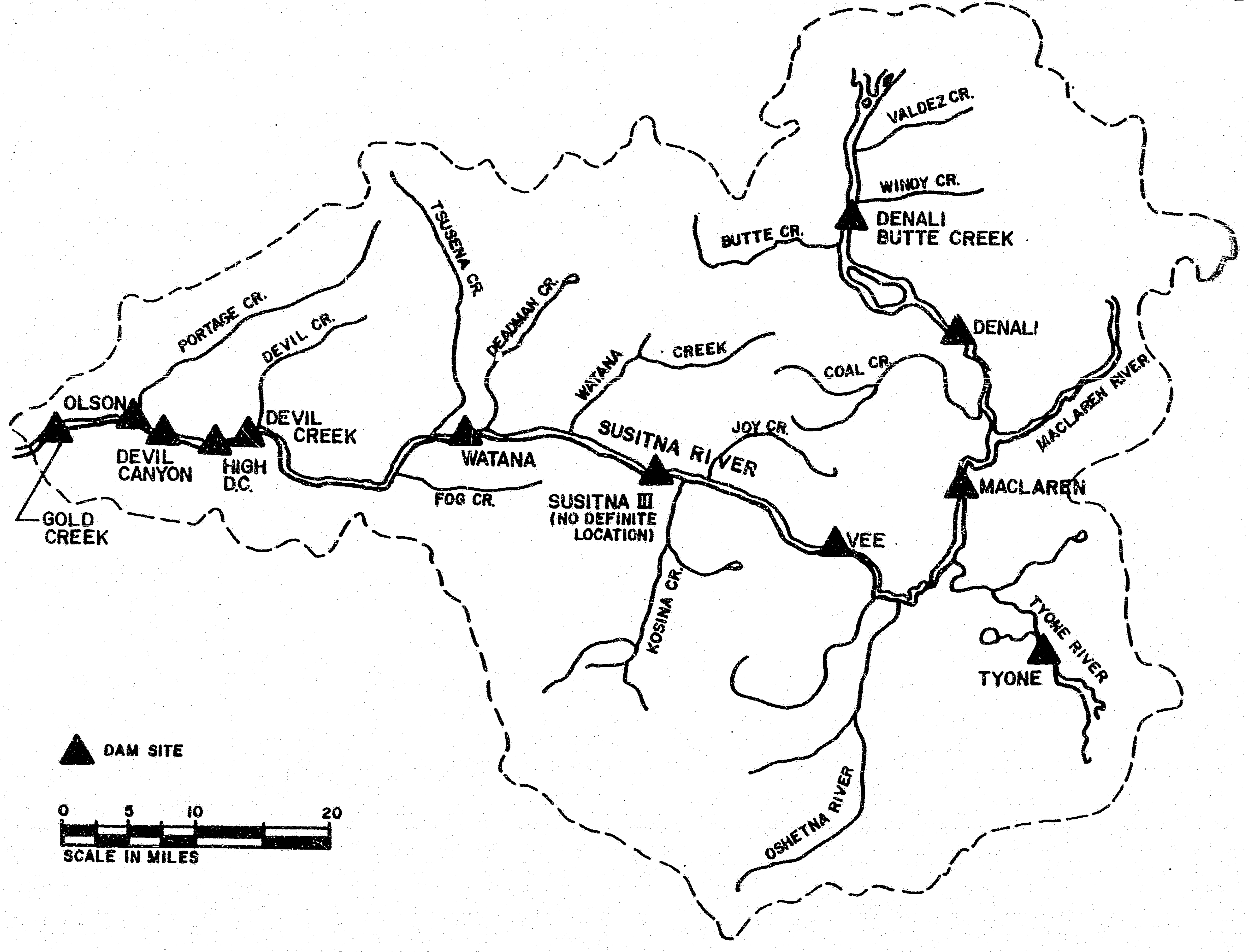
Acres American Incorporated (Acres) was commissioned by the Alaska Power Authority (Power Authority) on December 19, 1979, to conduct a detailed feasibility study of the Susitna Hydroelectric Project, evaluate the environmental consequences of any proposed development, and prepare a license application to be filed with the Federal Energy Regulatory Commission (FERC) in the event that the State of Alaska regards filing such an application as being in its best interests.

If development ever takes place in the Susitna River Basin (see Figure 1 for a basin map annotated to show potential dam sites), it is likely that extensive, costly and lengthy construction activity will occur there. Benefits of long-term and relatively low-cost electrical energy may be possible. Yet, permanent alteration of the environmental setting in the Basin will be inevitable.

The basis for a decision to proceed with the Susitna Hydroelectric Project requires that a variety of scientific, engineering, financial and economic disciplines be brought together. Investigations and analysis in each of these areas must necessarily be thorough and, further, should be consistent with state-of-the-art techniques. Documentation of these activities tends to be voluminous as well as highly technical in nature. The purpose of this Project Overview is to provide a review of all major aspects of the project and its objectives, determining in principle whether these can be met. In effect, it brings together complex issues and detailed technical results so that decision makers within the State of Alaska and interested members of the public can assess results achieved to date and determine what the future course of action should be with respect to the Susitna Hydroelectric Project.

Succeeding sections are arranged to present the framework within which the Susitna Study is conducted and the preliminary results achieved after the first full year of effort. Section 2 describes the decision process which requires two reports which the Power Authority must make to the Legislature. The nature and the role of the Power Authority are addressed in Section 3. After a brief history of the Susitna Project is presented at Section 4, Sections 5 through 13 consider technical, economic, environmental and marketing aspects. An introduction to the important public participation program follows at Section 14. Licensing and permitting is described in Section 15. Financial matters, including financial risks, are discussed in Sections 16 and 17. Section 18 describes the organizational arrangements necessary for effective project implementation. A final section (19) reviews the implications of proceeding with the work after the first decision point on March 31, 1981.

A detailed appendix to this overview has been prepared. It contains a complete chapter to correspond to each of the sections appearing herein. Copies of the detailed appendix have been furnished to the Power Authority and to its external review panel.



LOCATION OF DAM SITES PROPOSED BY OTHERS

FIGURE 1

In addition to this project overview, a second major document bears upon the March 31, 1981, decision process. The Development Selection Report (some of which is encapsulated in Sections 7, 8 and 9 below) provides the detailed basis upon which a recommendation has been made by Acres to APA regarding the proposed site on which the 1981 program will focus.

2 - THE DECISION PROCESS

Two important decision points have been designated by HCSSB 294. This legislation requires that the Power Authority, by March 30, 1981, submit a preliminary report to the Governor and to the State Legislature "recommending whether work should continue on the project." A second decision point, also explicitly legislated, occurs in April 1982, when the Power Authority must submit a second report recommending whether work should continue on the Susitna Hydroelectric Project and other viable alternatives. It is important to note that neither of these decision points is intended to produce a commitment to construct a project. Indeed, construction of dams and other facilities in the river channel is not possible until or unless an FERC license is awarded.

In addition to work being accomplished by the Acres team, several other ongoing activities bear upon the decision making process. A separate comprehensive study of alternative means of satisfying future Railbelt energy and load projections will be accomplished by an independent consulting firm under contract to the State of Alaska. The Susitna project will represent one of many possible alternatives considered in that effort. Other alternatives include, but are not necessarily limited to, thermal energy (particularly coal fired, since Alaska is richly endowed with significant undeveloped coal resources), wind, solar, non-Susitna hydropower, and tidal power (for which a preliminary assessment of potentials and constraints is now underway). In addition, the Power Authority has contracted with a major consulting firm specializing in electrical transmission to consider an intertie between Anchorage and Fairbanks. This latter project may be beneficial irrespective of whether the Susitna River Basin is ever developed, but the results of the study will necessarily be important to the analysis of transmission facilities required for a Susitna Project.

3 - ALASKA POWER AUTHORITY

The Power Authority was created in 1976, by action of the State Legislature, as an autonomous branch of the Alaska Department of Commerce and Economic Development. The basic mission of this agency is to develop energy generation projects (excluding nuclear) in an economical manner. Governed by a Board of Directors, the Power Authority employs an Executive Director and a staff which carry out day-to-day activities. Directors of Engineering, Finance, and Public Participation assist the Executive Director in performing his functions. The staff also includes a full-time Native Inspector, an Administrative Assistant, and Project Engineers and other supporting personnel. An organization chart is provided as Figure 2.

As of the end of 1980, the Power Authority was engaged in six reconnaissance studies, four design projects, two license application submittals, five construction projects, and eleven feasibility studies (Susitna being the largest).

Procedures adopted by the Power Authority for the Susitna study include the formation of a Steering Committee to ensure that interested State and Federal Agencies are kept informed throughout the course of the work and to provide a vehicle whereby their concerns and recommendations can be taken into account as the study progresses. Heavy emphasis is also placed on the opinions and concerns of the public, and an aggressive Public Participation Program is conducted.

4 - HISTORY OF THE SUSITNA PROJECT

Because of its strategic location between Anchorage and Fairbanks, the Susitna River has long been regarded as worthy of consideration for development of its hydroelectric potential. Shortly after World War II, the U.S. Bureau of Reclamation (USBR) did an initial Territory-wide reconnaissance, noting the vast hydroelectric potential in Alaska, and placing particular emphasis upon the perceived advantages of a Susitna Hydroelectric Project.

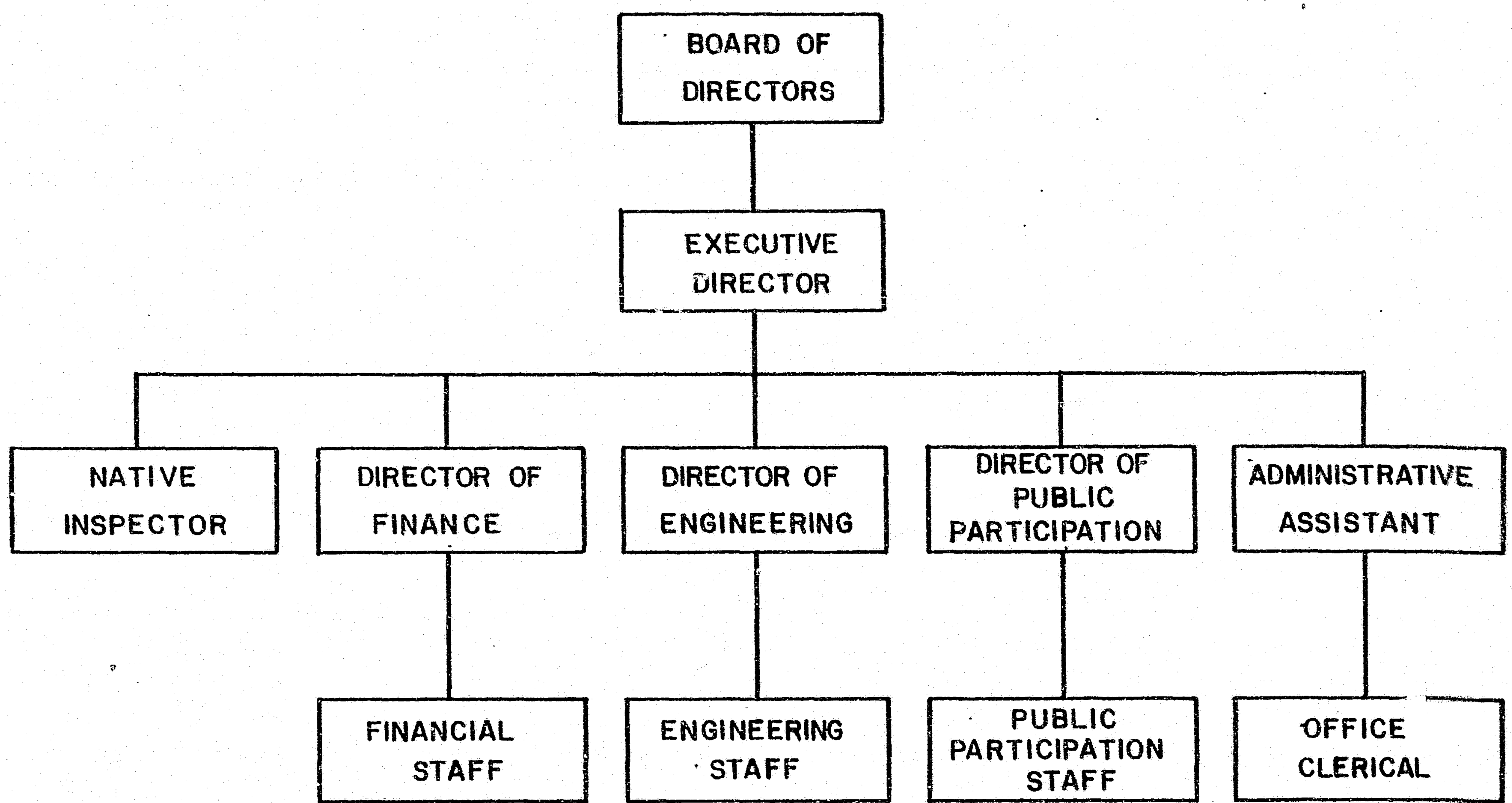
The U.S. Department of Interior (of which USBR was a part) undertook geotechnical and other field investigations and, in 1961, proposed authorization of a two-dam system on the Susitna River. This report was later updated in 1974 by the Alaska Power Administration (also then a part of DOI) and the desirability of proceeding with the project was reaffirmed.

The U.S. Army Corps of Engineers (COE) was also active in hydropower investigations in Alaska in the 1950's and 1960's. Focusing its initial attention on the Rampart Project on the Yukon River, the COE found by the early 1970's that the environmental consequences and limited market for Rampart power militated against its development. The 1973 energy crisis rekindled interest in hydropower development and the COE was commissioned by the U.S. Congress in 1974 to conduct a pre-feasibility study of the Susitna Project. The results of this effort were first referred to the Office of Management and Budget in 1976. Further geotechnical work followed and a new COE report was issued in 1979.

The State of Alaska itself commissioned an assessment of the Susitna Project by the Henry J. Kaiser Company in 1974.

Although differences appeared in the various proposed development schemes, all of the foregoing organizations were unanimous in recommending that Susitna hydroelectric potential be developed.

After the Power Authority was formed, the State of Alaska elected to proceed independently with a major feasibility study. A detailed Plan of Study was distributed widely in February 1980. Subsequent modifications, some of which



ALASKA POWER AUTHORITY ORGANIZATION

FIGURE 2

were occasioned by statements of public concerns, were directed by the Power Authority itself as well as by the State Legislature. Salient features of the Plan as it now stands are these:

- The development of electrical energy demand forecasts has been accomplished independently by the Institute for Social and Economic Research (ISER), University of Alaska.

- The study of alternatives, as noted earlier, is being accomplished separately from the Susitna Study.

- The Public Participation Program is handled by the Power Authority itself rather than by Acres as originally proposed.

- Major tasks have been designated to handle each facet of the work. These tasks include such activities as load forecasting, surveys and field support activities, hydrology, seismic studies, geotechnical investigations, design studies, environmental studies, transmission studies, development of cost estimates and schedules, licensing activities, finance and marketing studies, public participation and administration. Each task is further subdivided into subtasks so that more than 150 separately defined study activities will be completed prior to submitting a license application to FERC in June 1982--if affirmative decisions are made at the March 1981 and April 1982 milestones.

5 - ECONOMIC SCENARIOS AND PARAMETERS

The viability of a Susitna Hydroelectric Project depends to a great extent on the costs of generating electrical energy by alternative means. Thus, for example, if the cost of natural gas from the Cook Inlet area rises more rapidly in future years than the general inflation rate, it is likely that utilities will turn to sources other than gas for future expansion of generating systems. Hydropower might then enjoy a more favorable position. Conversely, if certain fuel prices rise less rapidly than the general inflation rate, hydropower may not necessarily represent an economical choice for future system expansion.

Other factors will also affect Susitna viability. For example, demographic variables, energy demand, unit labor costs, other commodity prices, overall price inflation, and interest and discount rates must be projected. An economic analysis was conducted so that, to the extent possible, logical and non-contradictory views of the world would emerge. No matter how carefully such an analysis is conducted, however, it is necessarily imprecise simply because it depends upon the prediction of an uncertain future. Thus a range of values bounding each selected parameter was selected as the basis for testing the sensitivity of a Susitna Project to possible deviations from most likely values.

Forecasts of world energy balances indicate a worldwide shortfall in oil supplies within ten years. By 1990, the United States is expected to be importing 16 percent of its energy needs (an improvement over the 22 percent level of 1978). It is likely that fossil fuel prices in the U.S. will continue to escalate at rates on the order of two to four percent above the overall inflation rate. Gas and oil price escalation will be at the upper end of this range, with coal escalation somewhat less. Fuel prices in Alaska will generally reflect market prices in the United States and abroad, less the cost of getting Alaskan fuels to the market.

Insofar as prospects for economic growth in Alaska are concerned, three different economic scenarios were developed by ISER. The lowest assumes only modest population and employment growths at just over two percent. The highest forecasts these values at closer to four percent. If the volume of State government expenditures varies significantly from current levels, these ranges will be broadened.

Opportunity values and escalation rates in Alaska in dollars per million Btu (where a Btu is a unit of energy) were selected as follows:

	$/Million Btu Opportunity Value (1980 Dollars)	1980 - 2005 Escalation in Excess of Normal Inflation
Natural Gas	$2.00	3.98%
Coal	$1.15	2.93%
Oil	$4.00	3.58%

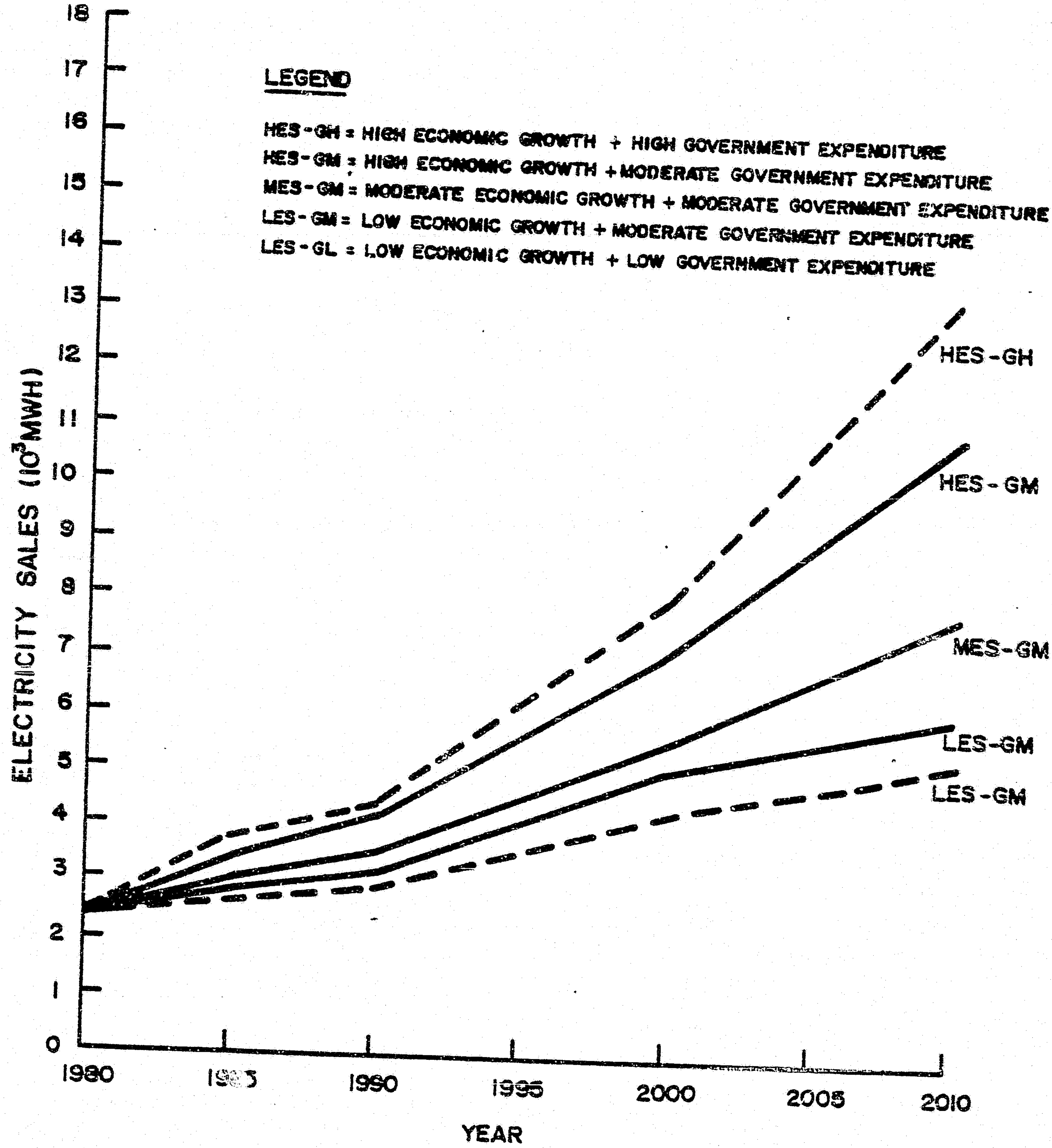
Exclusive of inflation, a real interest and discount rate of three percent was adopted as most likely.

6 - MARKET AREA AND POWER DEMAND FORECASTS

The forecasting methodology employed by ISER relied upon an end-use model rather than on the extrapolation of past trends as the basis for projecting future demand. As its name implies, an end-use model considers electricity consumption in terms of end use in various sectors of the economy. In the residential sector, for example, electricity consumption is largely attributed to space heating, refrigerators, water heaters, lights, cooking ranges, and certain other major appliances. Knowledge of the number, type, and expected changes in households can lead to assessment of future residential demand for electricity.

The annual growth in total Railbelt Utility Sales ranged from 2.8 percent to 6.1 percent in the lowest and highest economic growth scenarios respectively. These values may be compared to an actual average annual rate of 15.2 percent for the period 1940 to 1978 and to 11.7 percent for the 1970's. Figure 3 illustrates alternate demand forecasts.

Peak load forecasts were derived by applying historical load patterns by sector to the ISER demand forecasts. Peak loads are expected to increase at approximately the same percentage as total electrical energy demand for each of the selected ranges.



ALTERNATIVE UTILITY SALES FORECASTS

FIGURE 3

If more extreme measures are taken (probably through legislative action rather than voluntary efforts), some potential for further energy conservation and for load management could lead to a lower forecast than the lowest noted above. An extreme low forecast was selected for sensitivity tests in later analysis.

7 - SUSITNA BASIN STUDIES

During the past year, a massive field data collection effort got underway. Operating primarily out of a base camp constructed at the Watana site, investigative teams were engaged in environmental data collection, survey activities, geotechnical exploration, geological mapping, seismological investigations and hydrological and climatological data collection.

7.1 - Hydrology

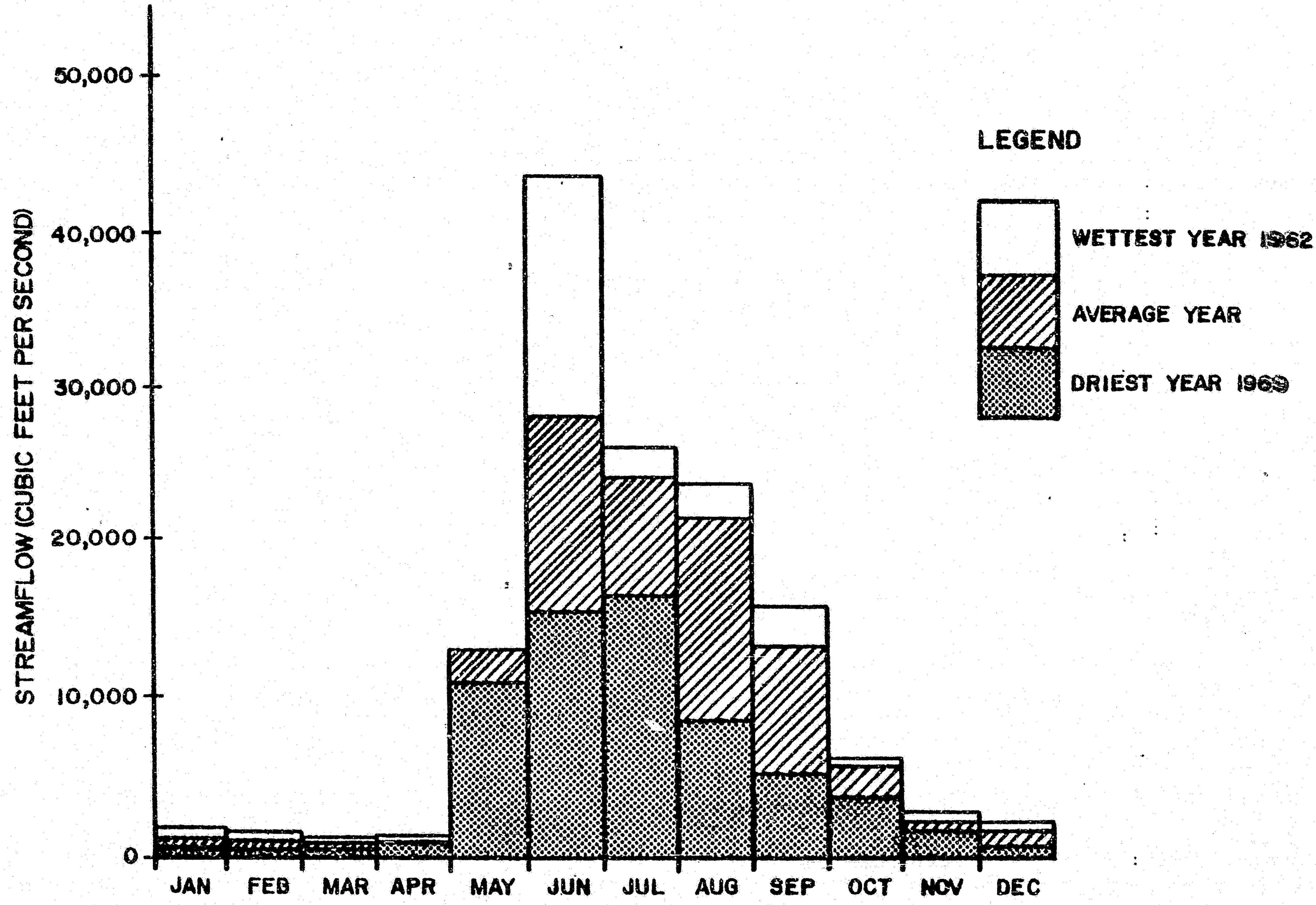
Gaging stations and weather monitoring stations were added to the network which had been installed and operated by State and Federal agencies in prior years. Information collected at new stations has been useful in correlating data obtained there with longer term records at older stations.

The Susitna River exhibits two distinct seasons of flow. High spring and summer flows (produced by snow and glacial melt and heavy rainfall) contribute about 90 percent of the annual total between May and October. The winter flow is relatively low and most of the smaller tributaries do not sustain flow during the coldest months. Figure 4 illustrates flow data at Gold Creek. Based on data collected to date, initial determinations have been made of probable maximum floods (the theoretical maximum which could be produced given the physical nature of the Susitna Basin) and design floods (1 in 10,000 year events) which must be safely passed by dams that might be constructed on the Susitna. In addition, of course, hydrological data was used to estimate probable average and firm energy outputs from potential developments. It is worth noting that less than 20 percent of the total Susitna River flow into Cook Inlet is contributed by the Susitna and its tributaries above Gold Creek. Significant contributions downstream occur from the Chulitna, Talkeetna, and Yentna Rivers. Figure 5 displays percentage composition of total flow by major tributary.

Ice formation, both in potential reservoirs and downstream of possible dams, continues to be studied, for it must be dealt with during construction and its impacts during operation must be determined.

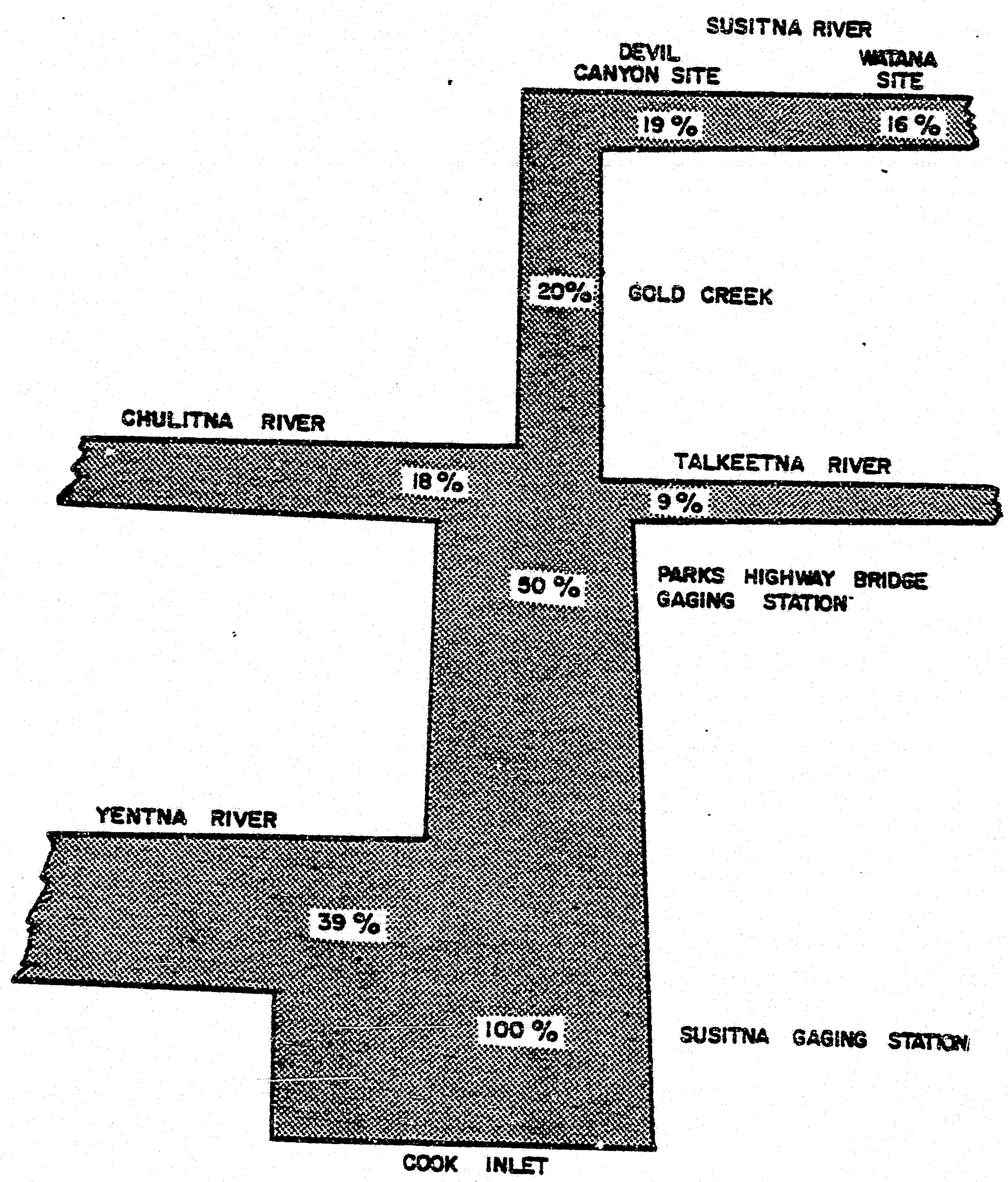
7.2 - Site Exploration and Geology

The Susitna Basin has a complex geology. Studies have been made of the region in general and detailed information was collected at particular dam sites and potential sites (borrow areas) for materials with which to construct the project. Three core holes per site were drilled at Watana and Devil Canyon during 1980; 15 auger holes were placed to explore borrow



SEASONAL DISTRIBUTIONS OF FLOW IN THE SUSITNA RIVER AT GOLD CREEK

FIGURE 4



AVERAGE ANNUAL FLOW DISTRIBUTION
WITHIN THE SUSITNA RIVER BASIN

FIGURE 5

areas; and approximately 28,000 feet of seismic lines were run. While geotechnical data gathered to date has generally confirmed the suitability of Watana and Devil Canyon sites for dam construction, a geotechnical program has been designed for 1981 further to define the nature of the sites and to answer questions about certain subsurface features which could influence the type and precise location of dams and other project features.

7.3 - Seismic Considerations

The Upper Susitna River Basin is a seismically active area. Thus, a major seismic program was started in 1980. A microseismic network of 10 stations was installed and operated to collect microearthquake data for the region. Potential faults and lineaments were identified by air and ground reconnaissance, satellite imagery, airborne remote sensing and aerial photography. A detailed screening of all identified features resulted in the selection of 13 for further study in 1981.

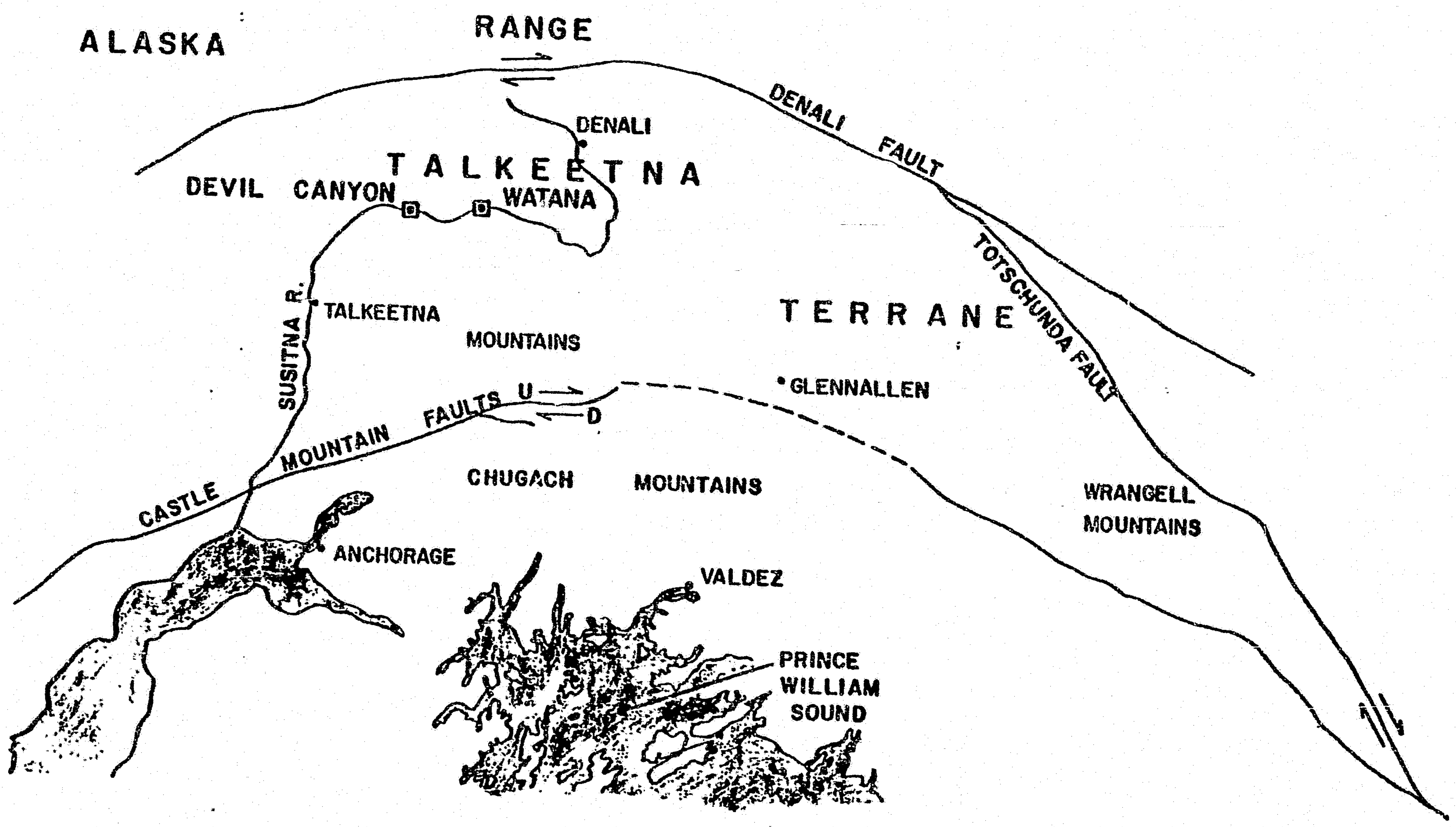
On the basis of the current state of knowledge, the Denali Fault (65 km north of the sites) and the Benioff Zone (60 km underground below the sites) are regarded as the most likely severe seismic hazards. Figure 6 illustrates the seismic setting. Initial estimates of maximum credible earthquakes from these features suggest a magnitude of 8.5 on the Richter Scale. Dam design to safely withstand ground accelerations associated with such an event is within the state of the art.

A study of Reservoir Induced Seismicity (RIS) was also initiated in 1980. RIS may be caused by the increased weight of water in a new reservoir or by lubrication and hydraulic action upon highly stressed rock. Based on evidence gathered to date, an RIS event will not exceed the maximum credible earthquake that could be associated with a fault. Thus, RIS is not likely to affect the determination of design earthquakes.

7.4 - Dam Site Selection

A total of 12 dam sites was considered in the site selection process (See Figure 1). By combination of two or more sites as a system, the total basin potential can be developed in a variety of ways. A detailed screening of individual sites and logical combinations of sites permitted elimination of those whose relative costs were high or whose obvious environmental disadvantages were large. Preliminary layouts were developed for each of the most promising sites.

Candidates selected for further analysis in generation planning and for more thorough environmental consideration included (1) the Watana and Devil Canyon dam sites (the combination found most suitable by the COE in the 1976 and 1979 studies); (2) High Devil Canyon (favored by Kaiser in 1974) and Vee; and (3) a combination of a Watana dam, a relatively low re-regulation dam midway between Watana and Devil Canyon and a tunnel from the low dam with a downstream portal near Devil Canyon. Within these groups, further



SUSITNA PROJECT SEISMIC SETTING

FIGURE 6

13

variations were studied in terms of alternative dam types and heights and possible schedule variations.

8 - GENERATION EXPANSION PLAN

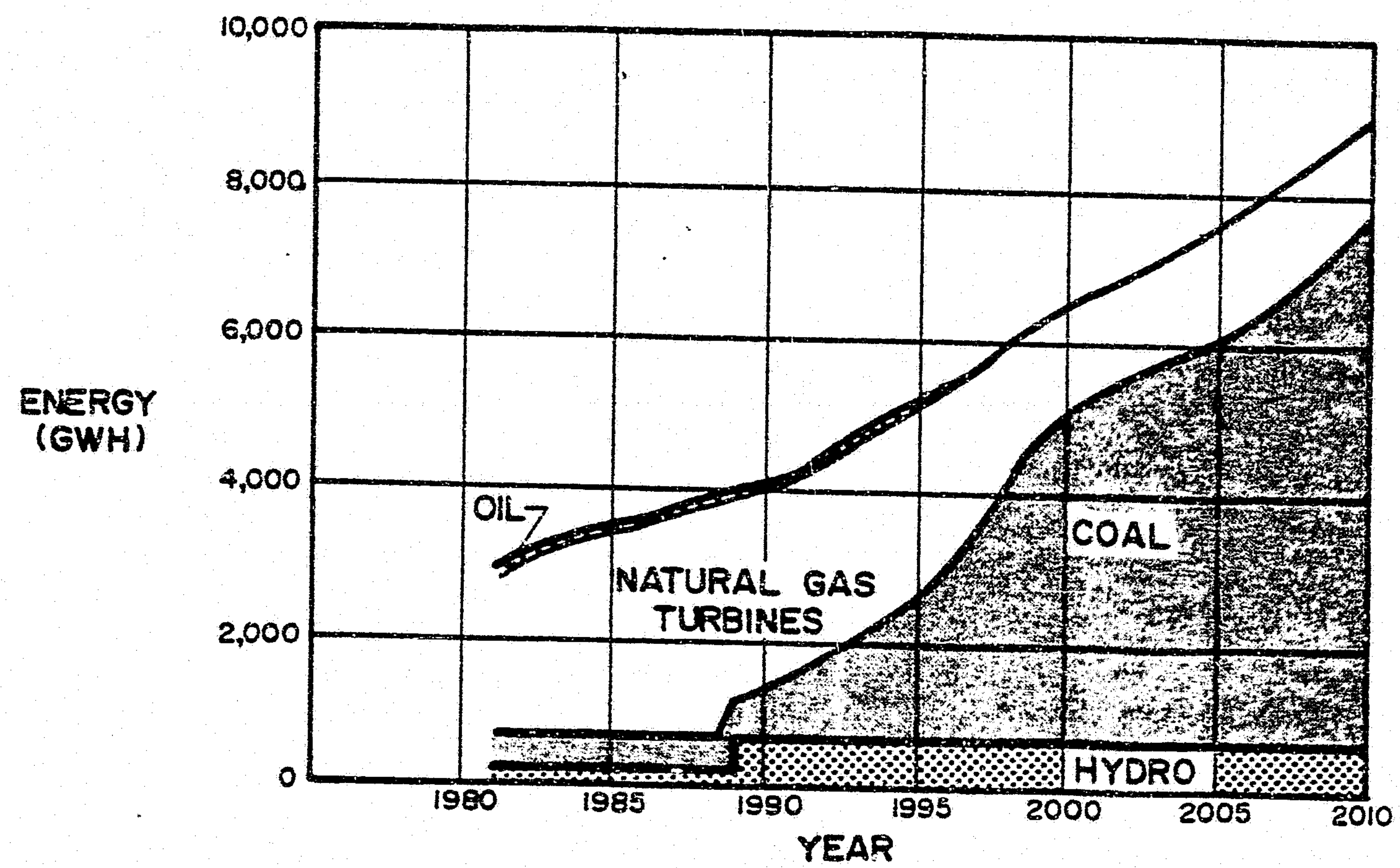
The current generation system in the Railbelt is primarily based upon thermal power. Natural gas is used heavily in the Anchorage area, oil fired units predominate in Fairbanks, and several small coal-fired plants operate at Healy and in the Fairbanks area. Hydroelectric energy, primarily from the Eklutna project, also contributes a small portion of the current Railbelt electric generation.

The present system will evolve in future years as demand increases and as old units reach the end of their useful lives. Regardless of whether or not a Susitna Project is ever developed, new system additions will be needed. For planning purposes, it was assumed that the Bradley Lake Project (now being pursued by the COE) and certain thermal units now under construction will be on line by the early 1990's. New capacity is necessary after 1992, but the amount and type to be added in any particular year will vary as a function of the demand and peak load forecasts.

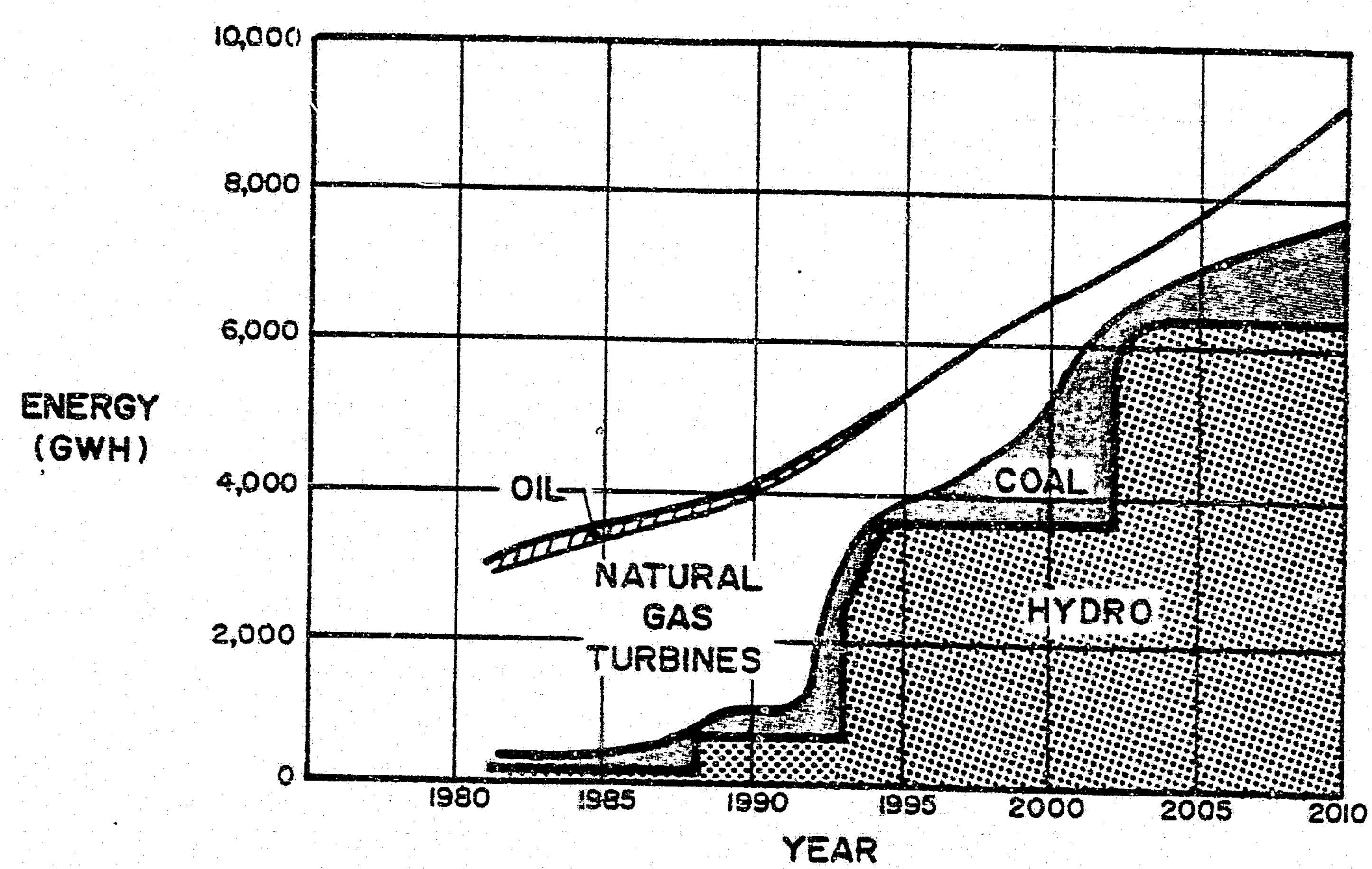
A generation planning exercise was conducted to determine how each of the potential Susitna developments might fit into future Railbelt generation systems. The General Electric Optimized Generation Program (OGP) was the primary tool used for this purpose. In addition to Susitna and present and planned capacity, major alternatives including coal-fired plants, gas turbines, gas-fired combined-cycle plants, and the ten best non-Susitna hydroelectric sites were considered as candidates for future expansion. On an economic basis, it was determined that Watana/Devil Canyon, High Devil Canyon/Vee, and Watana/Tunnel all produced total generation system present worth costs which were less than the least cost system without Susitna. Of the total sets considered, the Watana-Devil Canyon combination was favored economically. In the case of the most likely ISER forecast, the most appropriate time to bring an initial 400 MW Watana project on line was found to be 1993. Figure 7 provides a system energy comparison for the mid-load forecast for a base case thermal system and for a Watana/Devil Canyon development (Susitna 3AE).

Detailed generation planning analysis of the most promising development plans indicates that the Watana-Devil Canyon development plan is the preferred option. The studies to date clearly show that the tunnel option is higher in cost and provides less energy, but it may offer certain environmental advantages, in that approximately 15 miles of the Susitna River, including a part of Devil Canyon itself, would not be inundated. However, the environmental benefit would not at this time appear to be justified by the substantial additional cost and energy loss of this alternative.

Preliminary studies of tidal power potential have commenced. Tidal power development, if found feasible, would necessarily lag the earliest possible Susitna development simply because time-consuming detailed environmental and engineering investigations would have to be undertaken before a license application could be submitted to the FERC. Tidal power characteristics and



THERMAL



SUSITNA 3AE

SYSTEM ENERGY COMPARISON
MID LOAD FORECAST

FIGURE 7

costs will be available by mid-1981 as an input to the independently conducted Railbelt Alternatives Study. For generation planning purposes in the Susitna study, it has been assumed that tidal power generation is not available in 1993 when Watana could be brought on line economically.

A series of sensitivity tests was run to determine how variations in key parameters would affect the choice of favored plans. These tests generally demonstrated that the Watana-Devil Canyon development is the most cost effective alternative among Susitna Basin plans through a reasonable range of fuel costs, fuel escalation rates, real interest rates, and the like.

9 - SUSITNA HYDROELECTRIC DEVELOPMENT

The development selection activities are not yet complete, but the extensive study of the alternative dam and tunnel schemes for developing the power potential of the Susitna Basin indicate that High Devil Canyon and Watana are the two largest and most economic energy producers in the basin. Other sites such as Devil Canyon, Olson and Gold Creek are competitive provided they have additional upstream streamflow regulation. Sites such as Vee and Susitna III are medium energy producers although somewhat more costly than the larger dam sites. Sites such as Denali, Maclaren and Tyone are expensive compared to other sites. A comparison of the Devil Canyon site to the best tunnel alternative shows that the tunnel scheme is more expensive.

The environmental impacts of the various sites are a function of their location along the river.

Under existing conditions, salmon migrate as far as Devil Canyon, utilizing Portage Creek and Indian River for spawning. The development of any dam downstream of Portage Creek would result in a loss of salmon habitat. The necessary FERC license and permits for such development would probably be difficult to acquire. Between Devil Canyon and Watana, the concerns associated with development relate mainly to the inundation of Devil Canyon, which is considered a unique scenic and white water reach of the river, and has dam safety aspects associated with the occurrence of major geological faults. In addition, the Nelchina caribou herd has a general migration crossing in the area of Fog Creek. In the next upstream reach, between Watana and Vee, there are concerns which relate to the loss of some moose habitat in the Watana Creek area and the inundation of sections of Deadman and Lokina Creeks. Other aspects include the effect on caribou crossing in the Jay Creek area, and the potential for extensive reservoir shoreline erosion and dam safety because of the possibility of geological faults. Between Vee and Maclaren, inundation of moose winter range, waterfowl breeding areas, the scenic Vee Canyon and the downstream portions of the Oshetna and Tyone Rivers are all potential environmental impacts. In addition, caribou crossing occurs in the area of the Oshetna River. The area surrounding this section of the river is relatively inaccessible and

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development would open large areas to hunters. The segment between Maclaren and Denali, appears to be more sensitive than the area downstream of Vee. Inundation could affect grizzly bear denning areas, moose habitat, waterfowl breeding areas and moist alpine tundra vegetation. Improved access would open wilderness areas to hunters. The area upstream of Denali is similar to the reach immediately downstream with the exception of grizzly bear denning areas. Human access to this area would not impact to the same extent that it would downstream. However, due to the proximity to the Denali highway, the inflow of people could be greater.

Detailed generation planning analysis of the most promising development plans indicates that the Watana-Devil Canyon development plan is the preferred option. The studies to date clearly show that the tunnel option is higher in cost and provides less energy, but it may offer certain environmental advantages, in that approximately 15 miles of the Susitna River, including a part of Devil Canyon itself, would not be inundated. However, the environmental benefit would not at this time appear to be justified by the substantial additional cost and energy loss of this alternative.

It is considered essential that the continuation of studies in the Susitna Basin and, if appropriate, submission of a license application should be based on a preferred total Basin development concept. Thus, for the purposes of this report, it will be assumed that the Watana-Devil Canyon plan is the selected development.

The most appropriate plan of Watana-Devil Canyon development involves constructing the full height dam at Watana with a minimum installed capacity of 400 MW initially. The second stage involves adding an additional 400 MW capacity at the Watana site. The third major stage involves constructing the Devil Canyon dam and installing a minimum of 400 MW at that site. It should be stressed that these installed capacities are still approximate and subject to refinement during the 1981 studies.

Conceptual Design

The engineering layouts described are also preliminary and a considerable amount of additional study is currently underway to complete many of the details associated with these developments. In particular, further studies are being undertaken to firm up the general arrangement of the two dam projects; i.e., to determine the exact location of the dams, the dam types, the number and location of spillways, diversion and power tunnels and powerhouses. Also, the exact dam heights will be determined from more detailed economic studies and additional studies of reservoir operation will be undertaken to determine optimum operating policies. Throughout 1981 the environmental studies will be continued and the required reservoir operational constraints and necessary mitigation measures will be determined in more detail and incorporated in the design of the project. The river and ice field surveys and computer model studies also will continue with the results incorporated into the engineering studies.

Watana - The conceptual design involves a fill type dam incorporating a central core of impervious material. Properly graded filters are located both upstream and downstream of the core, supported by shells comprised of compacted, quarried rockfill and/or gravels and cobbles.

At this stage it is assumed that foundations will be excavated to bedrock beneath the entire dam and to sound rock beneath the core and filters. The bulk of the rockfill material will be taken from quarry areas located on the left abutment although some will be recovered from excavations for the various structures.

Gravels and cobbles and filter materials will be recovered from the excavated riverbed borrow areas and processed as necessary. Core material will be taken from borrow. The extent to which river gravels and cobbles can be utilized in the dam shells will be investigated from both technical and economic considerations in 1981.

The overall maximum height of the dam is approximately 840 feet above existing rock level. Allowance has been made for static and dynamic settlement, wave runup and freeboard, and potential deformation under seismic shaking. Upstream and downstream slopes average 1:2.75 and 1:2, respectively, and crest width is 80 feet. Shafts and galleries will be provided within the rock foundations and abutments for grouting and pressure relief drains.

Construction of an alternative concrete arch dam at Watana appears to be technically feasible but greater in cost. This option will be investigated further in 1981, but at this time, a fill dam appears to be the most suitable at this site.

Devil Canyon - A thin concrete arch dam, similar to that proposed by the U. S. Bureau of Reclamation (USBR), with a central integral spillway, is currently being analyzed for gravity, hydrostatic, temperature and seismic loadings.

The preliminary geometry for a two-center arch dam designed around the asymetric shape of the valley has been laid out, and stress analysis under gravity, hydrostatic and temperature loadings is proceeding. Vertical sections through the center of the dam take the form of a cupola with upstream and downstream faces formed by simple vertical curves. The foundation at the center is somewhat thicker than proposed by the USBR with a general increase in area occuring at the more highly stressed sections.

The overall maximum height of the dam is approximately 625 feet above existing rock level, with a crest width of 20 feet. As currently conceived, the power facilities including the power intake structure, will be kept separate from the dam. Shafts and galleries will be provided outside the dam to facilitate grouting and drainage.

Studies are currently underway to confirm the technical feasibility of constructing the thin arch dam and to evaluate in more detail the costs associated with this type of concrete dam. Evaluation of alternative rockfill and concrete dams at this site is also being undertaken.

Spillways

The reservoirs at Devil Canyon and Watana will be operated in accordance with "rule curves" defining normal operating water surface levels over a given period. These levels are contained by an envelope of extreme upper and lower surface elevations for normal operating conditions. If the reservoir level rises above the maximum normal operating level and the excess reservoir inflows cannot be absorbed by the power facilities, this excess flow must be released from the reservoir and discharged downstream. Spillways are provided at both sites to accommodate these releases.

The spillways may consist of one or more facilities each combining a gated control or a simple overflow structure, a discharge chute and some means of dissipating the energy of the released water downstream of the dam. The combined facilities at each site are designed to contain reservoir levels below an allowable surcharge level for floods corresponding to a frequency of occurrence of 1 in 10,000 years. These flows will be discharged with no significant damage at the site. The discharge capacity of the structures also will be checked to ensure their ability to pass flows corresponding to the probable maximum flood (the maximum flood that may occur from a coincidence of extremes of all influencing factors such as precipitation, temperature and snowpack) without overtopping the dam crest.

At present, spillways have been examined as part of the concept of comparing various sites from an economic and energy standpoint and selecting certain sites for further study. To simplify this comparison, a common form of spillway has been utilized which will be viable at all sites, but may not represent the most economic arrangement at any one particular site. During 1981, comparisons of various types of spillways at the selected sites will be made before a particular type is decided upon. Consideration is also being given to separate emergency spillways to handle extreme floods in excess of the 1 in 10,000 year or other selected design floods.

Watana - At its upstream end, the spillway consists of a concrete gravity control structure with five water passages, incorporating ogee-crested weirs and vertical lift gates. Downstream of the control structure is an inclined open chute excavated in rock. The chute is lined with concrete and runs to an intermediate stilling basin where the energy at that point is dissipated in the form of a hydraulic jump. An additional lined chute continues to a downstream stilling basin situated close to river level.

Possibly more economical spillway systems such as one or more single-chute flip-bucket and plunge-pool arrangements, or a combination of single-chute flip-bucket and stilling basins are currently being studied together with a separate emergency spillway with a breachable fuse plug.

Devil Canyon - At Devil Canyon a similar system to Watana has been located on the right abutment. It is envisaged that future studies will consider a spillway of restricted capacity discharging through openings below the dam crest with near vertical discharge into a plunge pool, in combination with one or more chutes and flip-buckets discharging into a separate downstream plunge pool. Alternatively, concrete lined tunnels and flips also discharging into a plunge pool, will be evaluated as well as a separate emergency spillway with a breachable fuse plug. Spillways may be situated on either or both of the abutments.

An alternative dam design in which it will be possible to discharge over the dam crest via a chute located on the downstream face into a lined stilling basin, is also being evaluated.

Power Generating Facilities and Equipment

For the preliminary planning purposes, a similar arrangement of the power facilities has been utilized at all sites, including Watana and Devil Canyon. The system consists of an upstream approach channel and intake structure discharging into concrete-lined penstocks dropping to an underground powerhouse complex. Concrete-lined tailrace tunnels lead from the powerhouse to the river located downstream of the toe of the dam.

The intake is a concrete structure founded in a rock cut and situated at the end of the approach channel. Provision is made for drawing off water at different levels within the reservoir in order to control the temperature of water released downstream. The present scheme allows for separate water intakes at three levels. Separate penstocks are provided for each turbine/generator unit. These are inclined at 55 degrees with steel-lined sections immediately upstream of individual turbines which are located in an underground powerhouse. The turbine/generator units, service bay, workshop, switchgear room and some offices are located within the main powerhouse cavern. The turbines and generators are serviced by overhead cranes running the length of the powerhouse cavern including the service bay area.

A separate transformer gallery is located upstream of the powerhouse cavern and a draft tube gate gallery just downstream of the powerhouse cavern with gates operating in vertical shafts descending to the four draft-tube tunnels. Isolated phase bus ducts located in separate inclined galleries connect each generator to a separate transformer. Power cables exit via vertical shafts to the switchyard at the surface. Vehicle access to the caverns is via unlined tunnels with additional personnel access provided by an elevator shaft to the surface.

The control room and administration offices are housed in a separate building at the surface adjacent to the switchyard.

The draft tube tunnels terminate in a common manifold. Two tailrace tunnels exit from the manifold and terminate in outlet structures located at the river downstream of the dam. These downstream tunnels are concrete-lined, and provision is made to seal off the tunnels for maintenance by inserting stop logs at their outlets.

Watana - The power facilities described are presently assumed to be within the left abutment and are based upon 4 - 200 MW turbine/generator units. However, it is possible that the rock quality and orientation of the jointing in this abutment will prevent the economical excavation of the long power caverns. Alternatively, relocation to the right abutment or a surface powerhouse on either abutment could be utilized. These alternatives will be examined and the most suitable system selected.

Devil Canyon - A similar layout to that at Watana is presently assumed at Devil Canyon based upon 2 X 200 MW turbine/generator units and located within the right abutment, with the intake located upstream of the dam.

Access Roads

A study is currently underway to determine the most desirable location for an access route and the most economical transportation modes. R&M Consultants are conducting this work as a subcontractor to Acres.

Three general corridors have been selected to provide access to potential dam sites. These include a corridor located to the North and another to the south of the Susitna River linking each site either to Highway 3 near Hurricane, or the railroad near Gold Creek (alternatives 1 and 2) or road access from the Denali Highway to the east of the project sites (alternative 3).

Using design criteria generally conforming to primary highway design several feasible alignments within the selected corridors were sketched on contour maps. From these the route within each corridor showing the most advantageous grade, alignment and length characteristics were selected.

These routes allow consideration of a number of transportation alternative plans including allowance for staged upgrading of the road and utilizing rail transporation segments.

The environmental considerations of each route as well as land ownership constraints are currently being addressed, in addition to transportation economics. In March, 1981, a series of public workshops will be held to gain public input to the route selection process. It is anticipated that a final decision on the selected route will take place during 1981, following which further engineering and field studies will be undertaken for the selected route.

Mitigating Measures

In developing the detailed project designs a range of mitigating measures required to minimize the impact on the environment will be incorporated. This is achieved by involving the environmental studies coordinator as a member of the engineering design team. This procedure ensures constant interaction between the engineers and environmentalists and facilitates the identification and design of all necessary mitigation measures.

There are two basic types of mitigation measures that are being developed: Those which are incorporated in the project design and those which are included in the reservoir operating rules. These are briefly discussed below.

Design Features - The two major design features currently incorporated include multi-level power intake structures to allow some temperature control of released water and provision of a downstream re-regulation dam to assist in damping the downstream discharge and water level fluctuations induced by power peaking operations at the dam. During the 1981 studies these two features will be designed in more detail and other features incorporated as necessary. Of particular importance will be the design of the spillways to eliminate or minimize the impact of increased nitrogen in the downstream river reaches.

Consideration will also be given to developing mitigation meaures to limit the impact on the environment during the project construction period. The access roads, transmission lines and construction and permanent camp facilities will also be designed to incorporate mitigation measures as required.

Operating Rules - Limitations on seasonal and daily reservoir level drawdown, as well as on downstream minimum flow conditions have been imposed in plan formulation studies. During 1981, more detailed studies will be undertaken to refine these current constraints and to look at detailed operational requirements to adequately control downstream water level fluctuations, water temperature and sediment concentration.

10 - ENVIRONMENTAL PROGRAM

A major environmental investigation program got underway in 1980. In addition to necessary exhaustive field data collection, effort was devoted in particular to two other major components: (1) addressing major environmental concerns including those expressed by government agencies (at Federal, State, and local level) and the general public, and (2) environmental participation in the design process with a view toward avoiding or minimizing impacts by making design decisions which account for environmental concerns from the start.

The environmental studies are divided into nine specific study components:

- Fisheries
- Wildlife
- Land Use
- Archaeological (Cultural Resources)
- Recreation
- Plant Ecology
- Corridor Selection
- Socioeconomic (See paragraph 11 below)
- Management and Coordination

At least one more year of data must be collected in each area before detailed impact statements can be prepared and proposals developed as appropriate for mitigative measures. Even so, no evidence has been discovered to date to indicate environmental impacts which are so severe as to conclusively rule out the possibility of developing the Susitna River for hydroelectric power production.

Certain environmental impacts on fisheries experienced at other major hydroelectric projects will be absent from or less severe at the Susitna Project if it is ever constructed. These include:

(a) No direct blockage of fish migration or escape will result from the dam itself.

(b) No significant river diversions resulting in low flows in the diverted river will occur for the Watana-Devil Canyon combination.

(c) Regulation is being factored into design to eliminate significant daily fluctuations in flow.

(d) Nitrogen entrainment will not be increased by numerous sequential reservoirs such as are found on the Columbia River. In addition, design studies will incorporate the latest available technology to reduce the occurrence of such phenomena.

11 - ANALYSIS OF SOCIOECONOMIC IMPACTS

A major socioeconomic study program was launched in 1980 with the objectives of describing existing socioeconomic conditions, forecasting future conditions if no Susitna Project is built, and determining which conditions are most likely to be impacted by a Susitna development.

Major efforts have been devoted to development of socioeconomic profiles during 1980. The 1981 work will focus upon preliminary assessments of impacts which implementation of the recommended development plan could cause.

12 - ECONOMIC FEASIBILITY AND NET ECONOMIC BENEFITS

The analysis of the net economic benefits of the recommended development plan is being developed within the framework of traditional methodology. The general procedure considers the total costs associated with the project (construction, operation, maintenance, transmission, etc.). Benefits are the avoided costs of providing the equivalent power and energy from the next best alternative generating source.

A preliminary life-cycle cost analysis has been conducted for the recommended development plan as well as for other alternatives surviving the initial site screening process. This economic analysis assumed a three percent discount rate in real terms (i.e., the cost of money is assumed to be three percent higher than actual inflation rates during the planning period). In 1980 dollars, the present value costs of the recommended hydroelectric development (operated in the Railbelt System during a 60 year period for economic analysis) were less than the costs of the best thermal generation alternative.

More precise values for life-cycle net benefits will be determined as cost estimates are developed in detail for the optimized development plan in 1981.

13 - POWER AND ENERGY MARKETING

Whereas it can be shown that the Susitna Hydroelectric Project would be economical in the long term, it is nonetheless true that the relatively high capital cost of a major hydroelectric power development can lead to difficulties in financing the project or in marketing power and energy during the first few years of operation.

Preliminary financial studies have been conducted to determine the probable nature and extent of the problem of high front-end loading as well as to identify potential strategies for alleviating this. These studies will continue in 198[illegible]. Insofar as marketing is concerned, it must be assumed that the maximum price which Railbelt Utilites would pay at any given time for Susitna power and energy is equal to or less than the avoided cost of producing power and energy by the best available alternate means.

In the initial year of operation deliveries from Susitna will replace power and energy generated by existing thermal power plant and the avoided cost will be related to fuel, operating and maintenance expense. Only when the existing capacity reaches the point of needing replacement or new demand emerges, with which this existing capacity cannot cope, will it be possible to edge the Susitna price of energy up to the full cost.

The ongoing studies will deal with practical arrangements which can be made with the Railbelt Utilities to achieve equitable marketing terms under which Susitna energy can be introduced to meet a substantial portion of future system needs.

14 - PUBLIC PARTICIPATION PROGRAM

An aggressive public participation program was initiated for the Susitna Hydroelectric Project. Conducted directly by the Power Authority, major objectives are:

- To distribute information to the public,

- To solicit information from the public, and

- To ensure that public input is fully considered in the decision-making process.

Community meetings, workshops, an action system to ensure that response is provided to every comment or question written by the public, newsletters and mailing lists are vehicles by which these objectives are satisfied.

Of particular note is the fact that public comment and concern has directly influenced the course of the Susitna study. Such major changes from original study plans as the commissioning of a separate and independent alternatives study, the addition of a sociocultural study and an increased level of study for alternative developments in the Susitna Basin were largely prompted by public concerns.

The high level of activity in the Public Participation Program is expected to continue throughout the course of the study.

15 - LICENSING AND PERMITTING PROCEDURES

Regulatory requirements at Federal, State and local levels tend to be voluminous, complex, and time-consuming for any major power development. For the first several years, satisfaction of regulatory requirements will be the controlling factor on the schedule for final completion of a Susitna project.

The most significant initial regulatory requirement is the necessity to obtain a license from the Federal Energy Regulatory Commission (FERC). Should project feasibility be established and a decision made to proceed with the work, current plans call for submittal of an application in mid-1982 and for receipt of a license by 1985.

A detailed analysis of licensing and permitting requirements was conducted early in the course of the work in 1980 and a blueprint was drawn up to ensure that critical regulatory schedules can be met.

16 - FINANCIAL FEASIBILITY ANALYSIS

Financial analysis and risk assessment has been initiated but only carried forward to a limited extent pending the selection of the preferred development plan and the availability of appropriate capital costs of construction. One purpose of the preliminary financial feasibility analysis has been to establish the "envelope" within which the staging, design and operating configurations of Susitna are amenable to market financing based upon reasonable assumptions concerning financial markets and the inclinations of investors over the next 20 to 30 years.

A computer model, developed earlier for financial analysis of major capital intensive projects, has been tailored specifically to meet the unique requirements of Susitna. Using this model, it is possible to analyze the effect on financial feasibility resulting from variations in input assumptions. These inputs include phasing of major project stages, scheduling of construction outlays, energy and power production during initial years, pricing and revenues, returns on investment, contingency provisions, debt requirements, taxes, and financial market conditions. There has been close correlation with work carried out on generation planning, employing the OGP-5 modeling capability (as described in Paragraph 8).

Preliminary financial analysis indicates that viable options do exist for funding the project with various levels of involvement of the State of Alaska. Work during 1981/82 will focus on financial feasibility of the optimized development selection and will proceed in close collaboration with the financial consultants selected by the Power Authority at the end of 1980.

17 - SECURITY OF PROJECT COST AND REVENUE STRUCTURE

Decision makers responsible for public policy and for action within the financial and credit markets, as well as those at regulatory agencies, must be confident that the probability of unforeseen events seriously distorting the objectives of the Power Authority and its planners is sufficiently remote that government and private investors should commit substantial financial resources to the Susitna Project. A detailed risk analysis will be made of the various influences and possibilities, no matter how remote, that might impact the security of the project cost structure and its revenue flow. In particular, consideration will be given to risks, and to the formulation of contingency plans, applicable to:

- Potential variations in capital costs
- Cost escalation
- Cost overruns
- Delays
- Events leading to noncompletion
- Serious outages during operation
- Failure of revenue from power resources
- Regulatory issues

Arising from the study of project cost and revenue structure will be consideration of the need for completion and/or other guarantees and revenue assurance requirements. The aim will be to develop strategies and procedures which will minimize risk in each category and provide for an acceptable balance of residual exposure and benefit for the financing entities which might be involved in the Project.

18 - ORGANIZATION AND MANAGEMENT

Project control structures, policies and procedures have been developed and put in place to ensure that continuing project activities are in the best interests of the State of Alaska and its populace. The Executive Director of the Power Authority serves as Project Manager for the State of Alaska. He is assisted in turn by a project staff which includes Assistant Project Managers for Technical Output and Schedule and for Budget and Finance. A Project Engineer within the Power Authority devotes his full-time attention to monitoring and coordinating project work.

Within the Acres organization, a Project Manager is responsible for direction of the activities of a large group of technical personnel. He is assisted by a Deputy Project Manager, a Technical Study Director, and a Resident Manager (in Anchorage).

External Review Panels have been established both at the Power Authority's level and at Acres' level to provide an independent check on the adequacy and accuracy of completed and proposed study activities.

Major subcontractors assisting Acres in the performance of its work include:

- R&M Consultants, Incorporated
- Cook Inlet Region Incorporated in association with Holmes and Narver
- Terrestrial Environmental Specialists
- Woodward Clyde Consultants
- Frank Moolin and Associates
- Robert W. Retherford Associates
- Other Alaskan firms providing transportation, supplies, and logistical support

19 - IMPLICATIONS OF PROCEEDING

The Governor of Alaska and the State Legislature will receive a report on or before March 30, 1981, wherein the Power Authority must recommend whether work should continue on the Susitna Hydroelectric Project. The Power Authority has selected four particular issues for detailed consideration. Conclusive proof that any one of these issues presents an insurmountable barrier would lead to a recommendation by the Power Authority to terminate the study. Briefly summarized, the issues are as follows:

- Are the forecasts too low to require any major generation additions over the next 30 years?

- Are seismic risks so great that safe development cannot occur?

- Are anticipated environmental losses unacceptable?

- Is there a significantly lower-cost set of alternatives which will satisfy demand forecasts through the year 2010?

No barriers have been discovered during the initial year of study which would lead to an affirmative answer to any of the listed questions. Even so, definitive answers have not yet been developed for all of the issues. Continuing the study would provide the State with an opportunity to make sound decisions in the future as to whether Susitna hydroelectric potential should ultimately be developed. Terminating study efforts at this time would result in avoiding the significant costs of further investigation and analysis on Susitna.

2 - PROJECT SCHEDULES

2. PROJECT SCHEDULES

The Plan of Study Master Schedule is shown on the 3 attached Figures.

TASK NO	DESCRIPTION
100	POWER STUDIES
101	REVIEW OF METHODOLOGIES
102	FORECAST PEAK LOAD DEMAND TRANS.
103	IDENTIFICATION OF POWER ALT
106	TERMINATION REPORT
200	SURVEYS AND SITE FACILITIES
202	FIELD CAMP SET-UP AND OPERATIONS
203	RESUPPLY AND EMERGENCY SERVICE
204	LAND STATUS SEARCH
205	LAND ACQUISITION ANALYSIS
206	RIGHT OF ENTRY
207	SITE SPECIFIC SURVEY
208	AIR PHOTOS AND MAPPING
209	CONTROL NETWORK SURVEYS
210	ACCESS ROAD
211	MAP AND PHOTO SEARCH
212	FIELD RECON FOR RESERVOIR CLEAR.
213	MARKETABILITY AND DISPOSAL STUDY
214	COST EST. FOR RESERVOIR CLEARING
215	SLOPE EROSION AND STABILITY STUDY
216	HYDROGRAPHIC SURVEYS
300	HYDROLOGY
301	REVIEW OF AVAILABLE MATERIAL
302	FIELD DATA INDEX OPERATION
303	FIELD DATA COLLECTION 80 - 82
304	WATER RESOURCES - STUDIES
305	FLOOD STUDIES
306	HYDRAULIC AND ICE STUDIES
307	SEDIMENT YIELD AND RIVER MORPHOLOGY
308	TRANSMISSION LINE - PRELIM PARAMETER
309	ACCESS ROAD HYDROLOGY
310	LOWER SUSITNA STUDIES
400	SEISMIC STUDIES
401	REVIEW AVAILABLE DATA
402	SHORT TERM MONITORING PROGRAM
403	PRELIM. RESERVOIR INDUCED SEISMIC
404	REMOTE SENSING IMAGE ANALYSIS
405	SEISMIC GEOLOGY RECONNAISSANCE
406	PRELIM. EVALUATION AND REPORT
407	PRELIM. GROUND MOTION STUDIES
408	DAM STABILITY
409	LONG TERM MONITORING PROGRAM
410	RESERVOIR INDUCED SEISMICITY
411	SEISMIC GEOLOGY FIELD STUDY
412	EVALUATION AND REPORT
413	GROUND MOTION STUDIES
414	DAM STABILITY (CONSULTING)
415	SOIL SUSCEPTIBILITY TO SEISMIC FAILURE
500	GEOTECH EXPLORATION
501	DATA COLLECTION
502	AIR PHOTO INTERPRETATION
503	1980 PROGRAM DESIGN
504	1980 EXPLORATION PROGRAM
505	1981 PROGRAM DESIGN
506	1981 EXPLORATION PROGRAM
507	1982 - 84 PROGRAM DESIGN
508	DATA COMPILATION

ACTIVITIES PRIOR TO LICENSE APPLICATION: 1980 (J F M A M J J A S O N D), 1981 (J F M A M J J A S O N D), 1982 (J F M A M J)

ACTIVITIES PRIOR TO AWARD OF CONSTRUCTION LICENSING: 1982 (J A S O N D), 1983 (J/F/M, A/M/J, J/A/S, O/N/D), 1984 (J/F/M, A/M/J, J/A/S, O/N/D), 1985 (J/F/M, A/M/J, J/A/S, O/N/D)

LEGEND

WORK COMPLETED TO FEBRUARY 1, 1981

WORK REMAINING - FROM FEBRUARY 1, 1981

CONTINUED WORK FOLLOWING LICENSE APPLICATION

SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY MASTER SCHEDULE

ACRES

FIGURE 1 OF 3

3 - NOTES ON SUSITNA BASIN DEVELOPMENT SELECTION

3 - NOTES ON SUSITNA BASIN DEVELOPMENT SELECTION

3.1 - Introduction

Section 3.2 of these notes briefly outlines the results of the development selection process undertaken to arrive at the proposed Susitna Basin plan, i.e. the Watana/Devil Canyon dam development. A brief description of the results of the comparison of railbelt generating scenarios, both with and without the Susitna Basin development, is also presented in Section 3.3.

The Appendix contains tables summarizing the parameters used for the systemwide economic evaluation of the various Susitna Basin development plans and the all thermal generating scenario. It also contains results from the generation planning model used for economic evaluation.

3.2 - Evaluation of Susitna Basin Development Plans

(a) Introduction

The Susitna Basin development studies commenced with the selection of 12 potential dam sites within the basin (see Table 1 and Figures 1 and 2). As shown in Figure 3, these sites were then subjected to a screening process incorporating economic, environmental, and total energy contribution criteria. In cases where two sites were located sufficiently close to each other and could be regarded as alternative sites one of them was also screened out. This screening exercise resulted in the most upstream sites such as Tyone and Butte Creek being screened out by the environmental, economic, and total energy contribution criteria. The energy potential at these sites is of a smaller order of magnitude that the major basin development options. Although also of low energy potential, the Maclaren and Denali sites were retained as they have potential for upstream regulation of flow for the larger power developments downstream. The two downstream sites, Gold Creek and Olson, were screened mainly because dams at these sites would impact upstream anadromous fish spawning areas in Portage Creek. All other dam sites are located upstream of Portage Creek which is known to represent the upstream limit of fish migration on the Susitna. The Devil Creek site was screened as it represents an alternative to the High Devil Canyon site.

Following the screening exercise and utilizing the assistance of operations research techniques and engineering layout and cost studies, the most economic basin development plans were selected. These plans were based on developing combinations of dams at the sites remaining after the screening exercise. This process revealed that the development plans incorporating dam combinations at Watana/Devil Canyon, High Devil Canyon/Vee, and High Devil Canyon/Watana are the most economic. Table 2 lists all the development plans selected and the associated costs and energy yields. Preliminary economic analyses indicated that it is not appropriate to stage actual dam construction but that the powerhouse construction at the larger dams such as Watana and High Devil Canyon is warranted.

Environmental assessment of the plans indicated that river flows resulting from daily peaking operations from the downstream dams could not be accepted. This required the introduction of reregulation facilities in certain cases and reductions in installed capacities at downstream dams in others. Table 3 lists the modified plans.

Based on the above information, it was decided to conduct a more thorough evaluation of the following two basic plans.

- Plan E1.5: Watana dam with two 400 MW powerhouse stages followed by Devil Canyon dam with a 400 MW powerhouse.

- Plan E2.3: High Devil Canyon dam with two 400 MW powerhouse stages followed by Vee dam with a 400 MW powerhouse.

It was also decided to investigate a long power tunnel alternative to developing the head at the Devil Canyon site as an alternative to the dam. This plan is referred to as 1.5 in Table 2.

The following subsection outlines the plan evaluation process and describes the selected development plan.

(b) Evaluation of Basin Development Plans

The evaluation process used involved consideration of the attributes of the various plans and a ranking of these plans based on comparisons of these attributes.

(i) Attributes

The following attributes are used to evaluate the short listed basin development plans:

- Economic

The parameter used is the total present worth cost of the total railbelt generating system for the period 1980 to 2040. This parameter is evaluated using an "economic" discount rate of 3%, 0% general escalation and specified rates of fuel cost escalation (see Appendix). The generation planning model OGP5 was used to plan the generation sequences for the 1980-2010 period. The 2010 generating system configuration was assumed to remain constant for the 2010 to 2040 period for purposes of evaluating the total system present worth cost.

- Environmental

A qualitative assessment of the environmental impact on the ecologic, cultural, and aesthetic resources is undertaken for each plan. Emphasis is placed on identifying major concerns so that these could be combined with the other evaluation attributes in an overall assessment of the plan.

- Social

This attribute includes determination of the potential nonrenewable resource displacement, the impact on the state and local economy and the risks and consequences of major structural failures due to seismic events.

- Energy Contribution

The parameter used is the total amount of energy produced from the specific development plan. An assessment of the energy development foregone is also undertaken. This energy loss is inherent to the plan and cannot easily be recovered by subsequent staged developments.

(ii) <u>Evaluation Process</u>

The various attributes outlined above have been determined for each plan and are summarized in table form. Some of the attributes are quantative while others are qualitative. Overall evaluation is based on a comparison of similar types of attributes for each plan. In cases where the attributes associated with one plan all indicate equality or superiority with respect to another plan, the decision as to the best plan is clear cut. In other cases where some attributes indicate superiority and other inferiority, these differences are high-lighted and trade-off decisions are made to determine the preferred development plan. In cases where these trade-offs have had to be made, they are relatively convincing and the decision making process can, therefore, be regarded as fairly robust.

In order to simplify the overall evaluation process, it is conducted in a series of steps. At each step, only a pair of plans is evaluated. The superior plan is then passed on to the next step for evaluation against an alternative plan. The results of this exercise are discussed in the following subsection.

(iii) Results of the Evaluation Process

The first step in the process involves the evaluation of the Watana/Devil Canyon dam plan and the Watana/Devil Canyon tunnel plan. As Watana dam is common to both plans, the evaluation is based on a comparison of the Devil Canyon dam and tunnel schemes.

- Devil Canyon Dam Versus Devil Canyon Tunnel

Table 4 lists the total present worth costs and Table 5 summarizes the economic evaluation. The results clearly demonstrate the economic superiority of the Devil Canyon dam scheme. The difference in present worth system costs amounts to $680 million. A general description of the environmental impacts associated with developing the Devil Canyon/Watana plan is given in Table 6. This information has been used to set up the environmental evaluation in Table 7 which indicates that the tunnel scheme has less environmental impact than the dam scheme. Table 8 lists the social attributes and indicates that the dam scheme has a higher potential for displacing nonrenewable resources than the tunnel scheme, and is therefore, superior. The impacts on the state and local economy and risks due to seismic exposure are judged to be similar for both schemes. Table 9 deals with the energy contribution attributes and illustrates that the dam scheme develops more of the basin potential than the tunnel scheme. The overall evaluation of the two schemes is summarized in Table 10. The dam scheme is judged to be superior since the cost savings associated with the dam are considered to outweigh the relatively modest reduction in the overall environmental impact.

The second step of the development selection process involves a comparison of the Watana/Devil Canyon and the High Devil Canyon/Vee development plans.

- Watana/Devil Canyon Versus High Devil Canyon/Vee

Table 4 summarizes the economic parameters while Table 5 outlines the economic evaluation of the plans. The Watana/Devil Canyon plan is economically superior by $520 million. Table 6 outlines the environmental impacts associated with the two plans while Table 11 summarizes the environmental evaluation. The Watana/Devil Canyon plan is judged to be environmentally superior. Table 8 summarizes the social evaluation and Table 12 the energy contribution evaluation. The Watana/Devil Canyon plan is superior in terms of both these attributes. Table 13 summarizes the overall evaluation and demonstrates the overall superiority of the Watana/Devil Canyon plan.

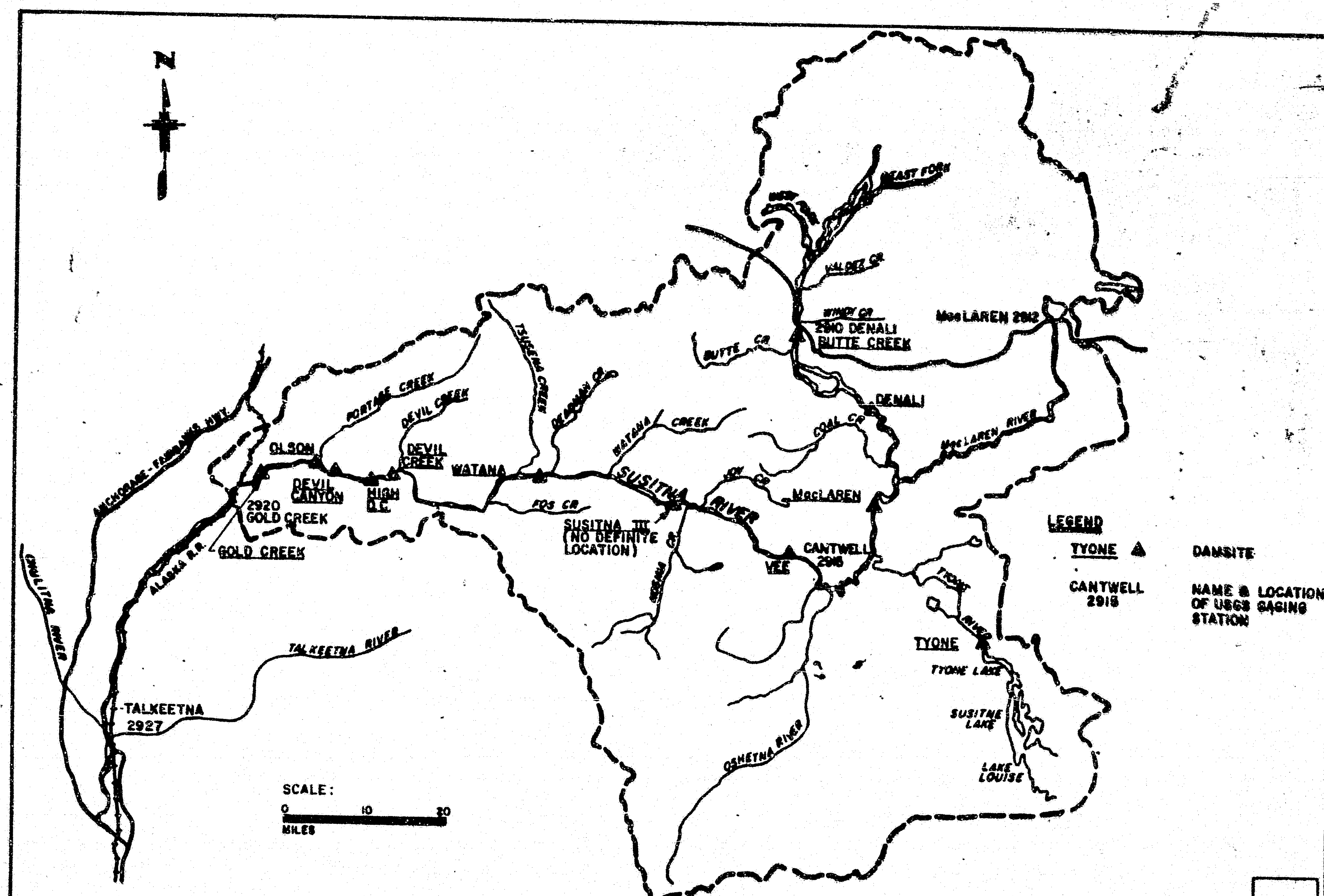
(c) Selected Development Plan

Based on the above discussion, the Watana/Devil Canyon development plan is regarded as the optimum Susitna Basin plan. Currently, engineering studies are in progress to further refine the size of the development (dam heights, installed capacities, etc.) and the design concepts. Figures 4 to 6 illustrate the operational characteristics of this development plan for a typical 30 year period.

3.3 - Comparison of Generation Scenarios Plan

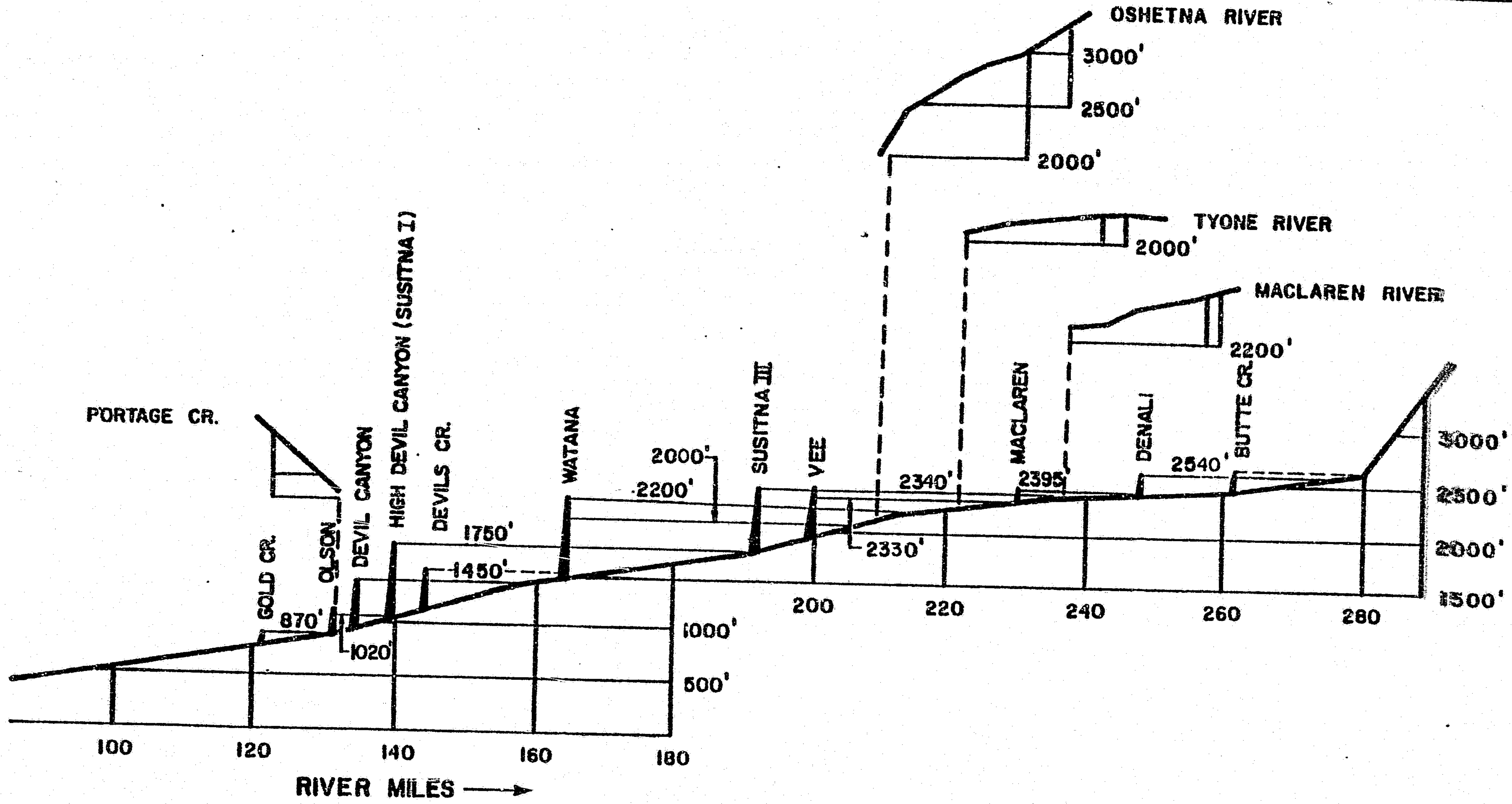
The selected Susitna Basin development plan has been compared with a limited number of alternatives by comparing generation scenarios for the Railbelt Region with and without the Susitna Basin development.

The two basic Railbelt generation scenarios compared are the all thermal scenario which relies on coal and gas fired generation and the with Susitna scenario incorporating the Watana/Devil Canyon dam plan as well as supplementary coal and gas fired generating facilities. Comparison of these two scenarios is based on the same attributes used for the Susitna Basin development selection. Table 14 summarizes the economic attributes and clearly indicates the superiority of the generation scenario incorporating the Watana/Devil Canyon plan. The superiority is maintained over wide ranges of anticipated future load projections and of the economic variables such as capital cost estimates, discount rate, fuel costs, fuel cost escalation, and economic plant life. The social comparison is summarized in Table 15. The scenario incorporating the Watana/Devil Canyon plan offers greater potential nonrenewable resource conservation. However, there is insufficient information currently available to undertake quantitative comparisons of impacts on state and local economies or of relative seismic exposures. Comparisons at this stage are, therefore, somewhat subjective. Table 16 broadly summarizes the environmental impacts associated with the two scenarios. However, specific information on potential future coal-fired generating sources is not available at this time and overall comparison is consequently uncertain. An attempted comparison is summarized in Table 17 from which it is tentatively concluded that the scenario with the Watana/Devil Canyon plan appears to be superior.



LOCATION OF DAMSITES PROPOSED BY OTHERS

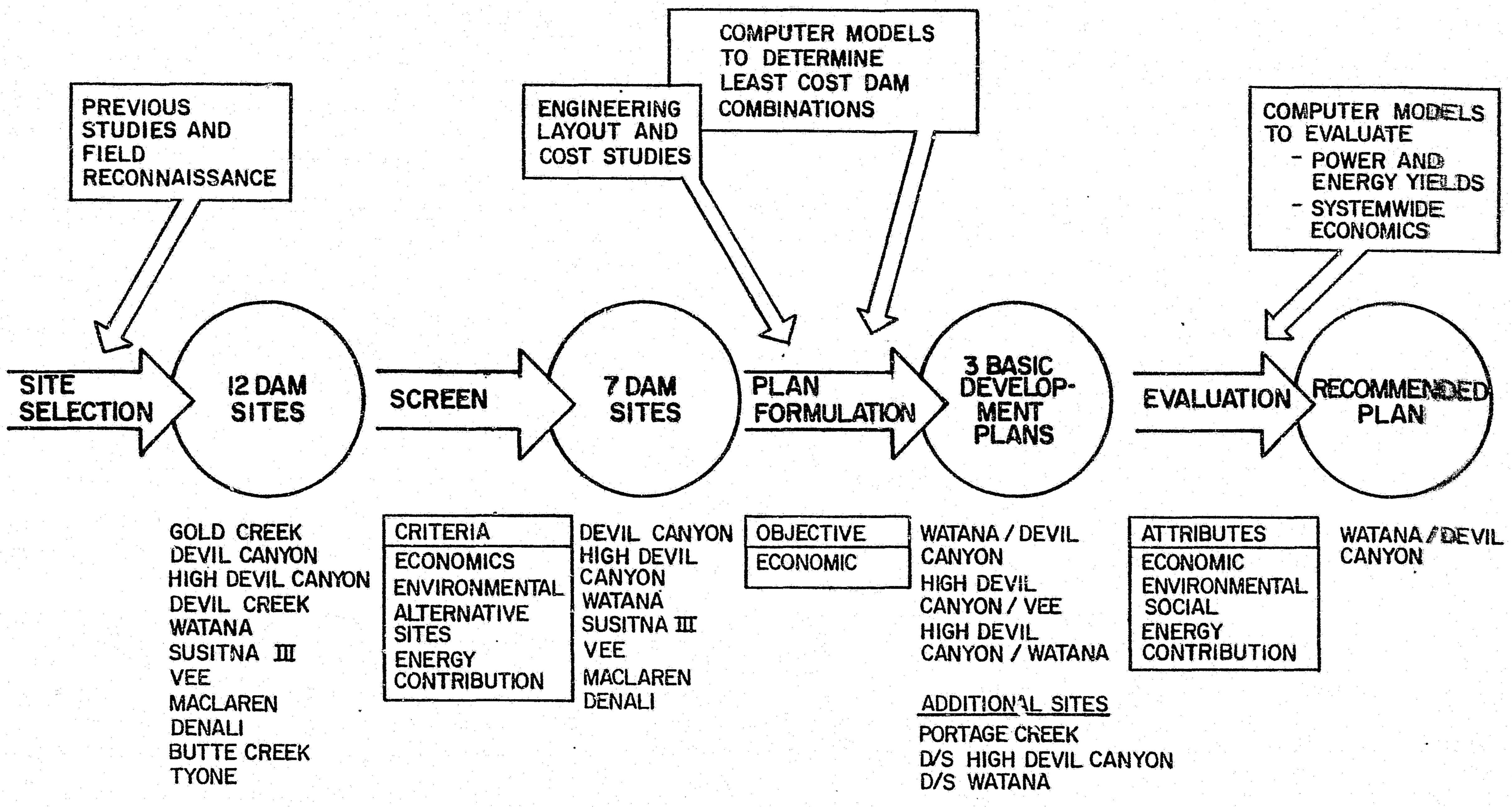
FIGURE 1



SUSITNA BASIN PROFILE AND POTENTIAL DAM SITES

FIGURE 2

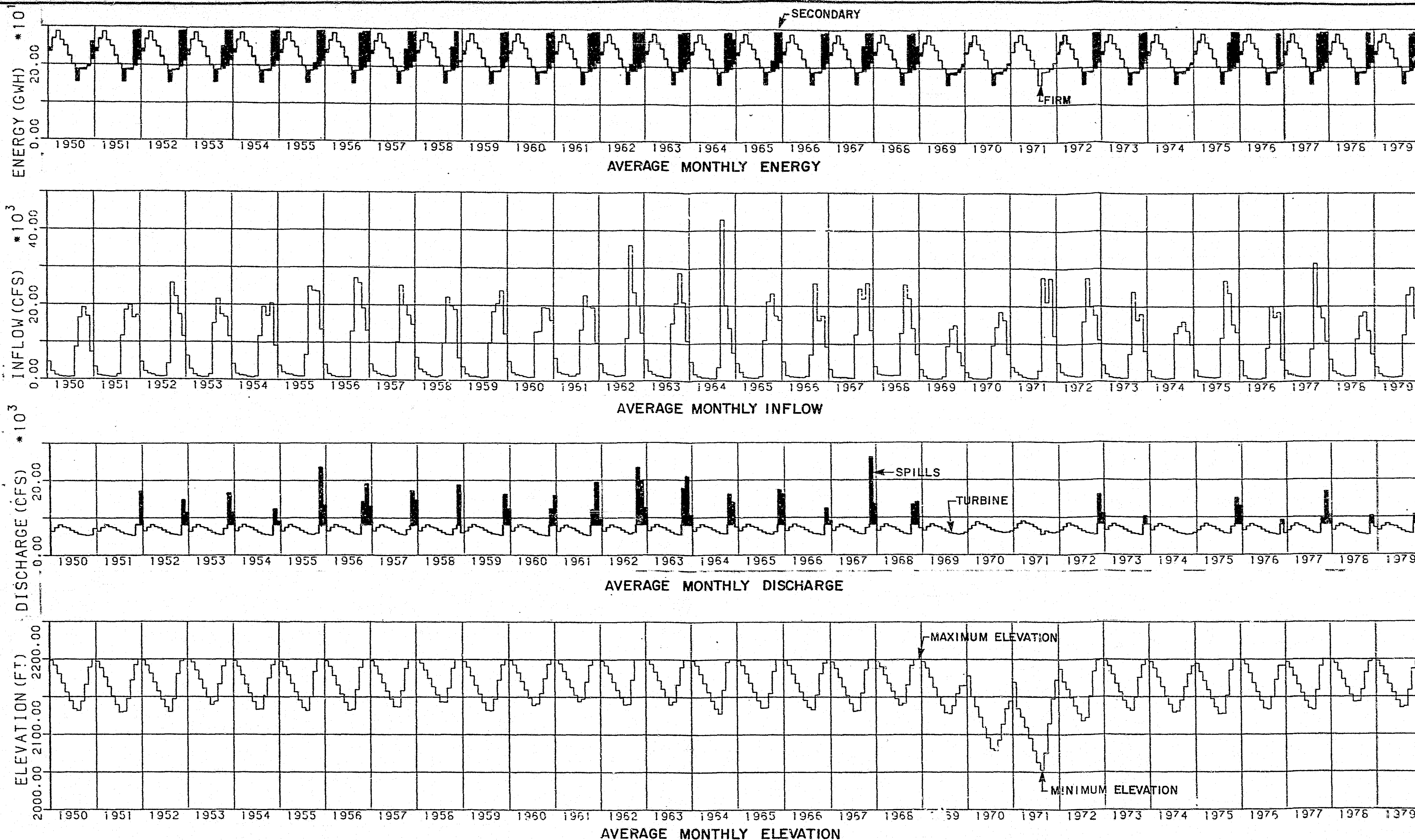
ACRES



SUSITNA BASIN DEVELOPMENT SELECTION PROCESS

FIGURE 3

ACRES



NOTE : WATER YEAR OCT.–SEPT.

STAGE I – WATANA RESERVOIR (400 MW)

OPERATION OF THE WATANA / DEVIL CANYON DEVELOPMENT PLAN E1.3

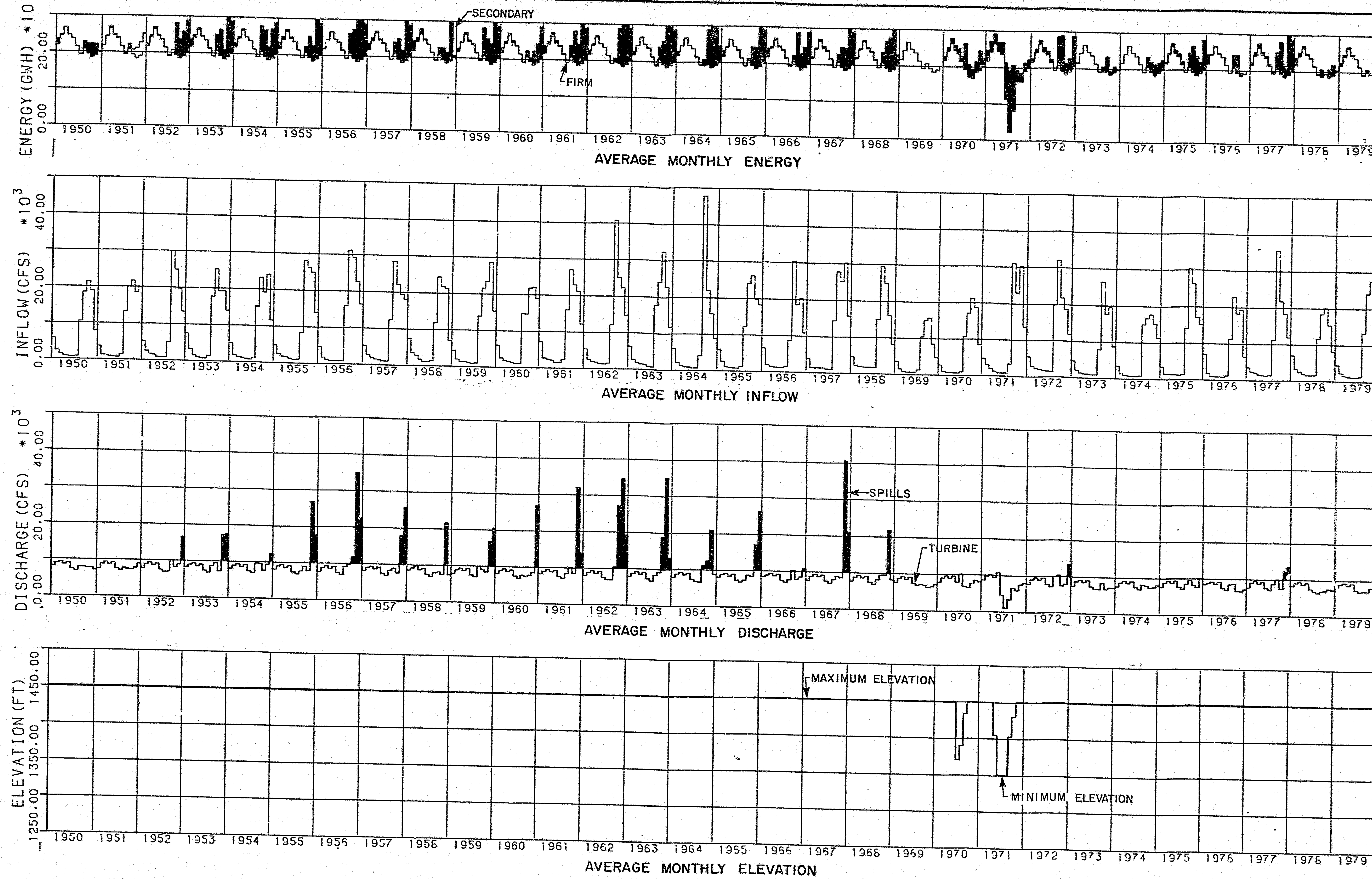
FIGURE 4

NOTE : WATER YEAR OCT.– SEPT.

STAGE 3 - WATANA RESERVOIR (800 MW)

OPERATION OF THE WATANA / DEVIL CANYON DEVELOPMENT PLAN E 1.3

FIGURE 5



NOTE: WATER YEAR OCT.-SEPT.

STAGE 3-DEVIL CANYON RESERVOIR (400 MW)

OPERATION OF THE WATANA / DEVIL CANYON DEVELOPMENT PLAN E1.3

FIGURE 6

TABLE 1 - POTENTIAL HYDROELECTRIC DEVELOPMENT

Dam			Upstream	Capital Cost	Installed Capacity	Average Annual Energy	Economic* Cost of Energy	Source of
Site	Proposed Type	Height Ft.	Regulation	$\$ \times 10^6$	(MW)	Gwh	$/1000 kWh	Data
Gold Creek**	Fill	190	Yes	900	260	1,140	37	USBR 1953
Olson (Susitna II)	Concrete	160	Yes	600	200	915	31	USBR 1953 KAISER 1974 COE 1975
Devil Canyon	Concrete	675	No Yes	830 1,000	250 600	1,420 2,980	27 17	This Study "
High Devil Canyon (Susitna I)	Fill	855	No	1,500	800	3,540	21	" "
Devil Creek**	Fill	Approx 850	No	-	-	-	-	-
Watana	Fill	880	No	1,860	800	3,250	28	"
Susitna III	Fill	670	No	1,390	350	1,580	41	"
Vee	Fill	610	No	1,060	400	1,370	37	"
Maclaren**	Fill	185	No	500	55	180	124	"
Denali	Fill	230	No	440	60	245	81	"
Butte Creek**	Fill	Approx 150	No	-	40	130***	-	USBR 1953
Tyone**	Fill	Approx 60	No	-	6	22***	-	USBR 1953

*Includes AFDC, Insurance, Amortization, and Operation & Maintenance Costs.
**No detailed engineering or energy studies undertaken as part of this study.
***These are approximate estimates and serve only to represent the potential of these two dam sites in perspective.

TABLE 2 - Susitna Development Plans

Plan	Stage	Construction	Stage/Incremental Data: Capital Cost $ Millions (1980 values)	Construction Period yrs.	Earliest On-line Date[1]	Reservoir Full Supply Level - ft.	Maximum Seasonal Draw-down-ft	Cumulative System Data: Annual Energy Production Firm GWH	Avg. GWH.	Plant Factor %
1.1	.1	Watana 2225 ft 800MW	1860	9	1993	2200	150	2670	3250	46
	.2	Devil Canyon 1470 ft 600MW	1000	6-1/2	1996	1450	150	5310	6230	51
		TOTAL SYSTEM 1400MW	2860							
1.2	.1	Watana 2060 ft 400MW	1570	8	1992	2000	100	1710	2110	60
	.2	Watana raise to 2225 ft	360	3	1995	2200	150	2670	2990	85
	.3	Watana add 400MW capacity	130	2	1995	2200	150	2670	3250	46
	.4	Devil Canyon 1470 ft 600MW	1000	6-1/2	1996	1450	100	5310	6230	51
		TOTAL SYSTEM 1400MW	3060							
1.3	.1	Watana 2225 ft 400MW	1740	9	1993	2200	150	2670	2990	85
	.2	Watana add 400MW capacity	150	3	1994	2200	150	2670	3250	46
	.3	Devil Canyon 1470 ft 600 MW	1000	6-1/2	1996	1450	100	5310	6230	51
		TOTAL SYSTEM 1400MW	2890							
1.4	1	Devil Canyon 1470 ft 250MW	830	6	1990	1450	100	1250	1420	65
	2	Watana 2225 ft 400MW	1740	9	1996	2200	150	3920	4410	77
	3	Watana add 400MW	150	3	1997	2200	150	3920	4670	51
	4	Devil Canyon add 350MW	200	3	1997	1450	100	5310	6230	51
		TOTAL SYSTEM 1400MW	2920							

TABLE 2 (Continued)

			Stage/Incremental Data					Cumulative System Data		
Plan	Stage	Construction	Captial Cost $ Millions (1980 values)	Construction Period yrs.	Earliest On-line Date[1]	Reservoir Full Supply Level - ft.	Maximum Seasonal Draw-down-ft.	Annual Energy Production Firm GWH	Annual Energy Production Avg. GWH	Plant Factor %
1.5	1	Watana 2225 ft 800MW	1860	9	1993	2200	150	2670	3250	46
	2	Watana add 50MW Tunnel 330MW	1500	5	1995	1475	4	4890	5430	53
		TOTAL SYSTEM 1180MW	3380							
2.1	1	High Devil Canyon 1775 ft 800MW	1500	8	1994[2]	1750	150	2860	3540	51
	2	Vee 2350ft 400MW	1060	7	1997	2330	150	3870	4910	47
		TOTAL SYSTEM 1200MW	2560							
2.2	1	High Devil Canyon 1630 ft 400MW	1140	7	1993[2]	1610	100	1850	2110	60
	2	High Devil Canyon add 400MW Capacity raise dam to 1775 ft	500	3	1996	1750	150	2860	3540	51
	3	Vee 2350 ft 400 MW	1060	7	1997	2330	150	3870	4910	47
		TOTAL SYSTEM 1200MW	2700							
2.3	1	High Devil Canyon 1775 ft 400MW	1390	8	1994[2]	1750	150	2400	2730	78
	2	High Devil Canyon add 400MW capacity	140	3	1995	1750	150	2860	3540	51
	3	Vee 2350 ft 400MW	1060	7	1997	2330	150	3870	4910	47
		TOTAL SYSTEM 1200	2590							
3.1	1	Watana 2225 ft 800MW	1860	9	1995[2]	2200	150	2670	3250	46
	2	High Devil Canyon 1470 ft 400MW	860	6	1998	1450	100	4550	5280	50
	3	Portage Creek 1030 ft 150MW	650	5	2000	1020	50	5110	5960	50
		TOTAL SYSTEM 1350MW	3370							

NOTES:
1. Allowing for a 3 year overlap construction period between major dams.
2. Assumes FERC license can be filed by June 1984, ie. 2 years later than for the Watana/Devil Canyon Plan 1.

TABLE 3 - Selected Susitna Development Plans (Environmental)

			Stage/Incremental Data			Cumulative System Data		
Plan	Stage	Construction	Capital Cost $ Millions (1980 values)	Reservoir Full Supply Level - ft.	Maximum Seasonal Draw-down-ft.	Annual Energy Production Firm GWH	Avg. GWH	Plant Factor %
E1.3	1	Watana 2225 ft 400MW	1740	2200	150	2670	2900	83
	2	Watana add 400MW capacity and Re-regulation dam	250	2200	150	2670	3250	46
	3	Devil Canyon 1470 ft 400MW	900	1450	150	5520	6070	58
		TOTAL SYSTEM 1200MW	2890					
E2.3	1	High Devil Canyon 1775 ft 400MW	1390	1750	150	2400	2730	78
	2	High Devil Canyon add 400MW capacity and re-regulation dam	280	1750	150	2860	3540	51
	3	Vee 2350 ft 400MW	1060	2330	100	3870	4910	47
		TOTAL SYSTEM 1200MW	2730					
E2.4	1	High Devil Canyon 1775 ft 400MW	1390	1750	150	2400	2730	78
	2	High Devil Canyon add 400MW capacity	140	1750	150	2860	3540	51
		Portage Creek 1030 ft 150MW	650	1020	50	3410	4190	50
	3	Vee 2350 ft 400MW	1060	2330	100	4430	5540	47
		TOTAL SYSTEM 1350MW	3240					

TABLE 4 - Economic Backup Data for Evaluation of Plans

Parameter	Total Present Worth Cost for 1981-2040 Period $ Million (% Total)		
	Generation Plan with High Devil Canyon/Vee	Generation Plan with Watana/ Devil Canyon	All Thermal Generation Plans
Capital Investment	2840 (44)	2750 (47)	2520 (31)
Fuel	3230 (50)	2750 (47)	5200 (64)
Operation and Maintenance	390 (6)	350 (6)	410 (5)
Total:	6460 (100)	5850 (100)	8130 (100)

TABLE 5

ECONOMIC EVALUATION OF DEVIL CANYON DAM AND TUNNEL SCHEMES AND WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE PLANS

		Present worth of Net Benefit ($ million) of total generation system costs for the: Devil Canyon Dam over the Tunnel Scheme	Watana/Devil Canyon Dam over the High Devil Canyon/Vee Dams	Remarks
ECONOMIC EVALUATION: Base Case		680	520	Economic ranking: Devil Canyon dam scheme is superior to Tunnel scheme. Watana/Devil Canyon dam plan is superior to the High Devil Canyon dam plan.
SENSITIVITY ANALYSES: Parameter	Sensitivity Analyses			
LOAD GROWTH	Low High	650 N.A.	210 N.A.	The net benefit of the Watana/Devil Canyon Plan remains positive for the range of load forecasts considered. No change in ranking.
CAPITAL COST ESTIMATE		Higher uncertainty associated with tunnel scheme.	Higher uncertainty associated with H.D.C./Vee plan.	Higher cost uncertainties associated with higher cost schemes/plans. Cost uncertainty therefore does not affect economic ranking.
PERIOD OF ECONOMIC ANALYSIS	Period shortened to (1980 - 2010)	230	160	Shorter period of evaluation decreases economic differences. Ranking remains unchanged.
DISCOUNT RATE	5% 8% (interpolated) 9%	As both the capital and fuel costs associated with the tunnel scheme and H.D.C./Vee Plan are higher than for Watana/Devil Canyon plan any changes to these parameters cannot reduce the Devil Canyon or Watana/Devil Canyon net benefit to below zero.		Ranking remains unchanged.
FUEL COST	80% basic fuel cost			
FUEL COST ESCALATION	0% fuel escalation 0% coal escalation			
ECONOMIC THERMAL PLANT LIFE	50% extension 0% extension			

TABLE 6

ENVIRONMENTAL IMPACTS ASSOCIATED WITH WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

River Reach	Environmental Attributes	Concerns	Difference in impact of two plans	Identification of difference	Appraisal Judgement
Downstream of Devil Canyon	Ecological	Change in water quality and quantity as it affects fish and wildlife.	NO Significant difference between plans.		Not a factor in plan comparison.
	Cultural	No downstream archeological concern.	--		Not a factor in plan comparison.
		Possible socio-cultural effects on downstream communities.	NO Significant difference between plans.		
	Aesthetic/ Land Use	Change in flow as it affects utilization of the lower river.	NO Significant difference between plans.		Not a factor in plan comparison.
Devil Canyon	Ecological	Minimal ecological concern in the canyon.	Minimal difference in potential impact.		Not a factor in plan comparison.
	Cultural	Potential inundation of archeological sites.	Probable minimal difference due to rugged nature of the canyon.		Not a factor in plan comparison.
	Aesthetic/ Land Use	Inundation of unique Devil Canyon.	Minimal difference in impacts assuming a re-regulation dam is built downstream of HDC.		Not a factor in plan comparison.
Devil Canyon to Watana Dam Site	Ecological	Utilization of the river valley by moose and bear. Caribou crossing in Fog creek area.	Difference between plans.	In the upper portions of this reach more of the river valley would be inundated with the HDC/V plan (HDC pool elevation is 1750' - W/DC pool elevation is 1450') with a potential greater impact on wildlife resources.	The wildlife impacts in this section would be less with the W/DC plan however due to the relatively small area involved this difference is not a major factor in plan evaluation.
		Resident Fisheries	Minimal difference between plans.	Both plans inundate approximately the same reach of the Susitna River however the HDC/V plan would extend approximately 1 more mile up Devil Creek and 3 more miles up the Tsusena Creek.	The HDC/V plan would create a greater impact on resident fisheries although the relative difference in this section of the river is minimal. This difference is considered a minor factor in plan evaluation.
	Cultural	Inundation of Archeological sites.	Minimal difference between plans.	Known and suspected archeological sites exist in this section of the river. HDC/V with its higher pool elevation has a greater possibility of inundated more archeological sites	Since none of those archeological sites have been designated as having a major significance and mitigation measures are available, this minimal difference is considered a minor factor in plan evaluation.
	Aesthetic/ Land Use	Loss of land use potential. Loss of aesthetics.	Minimal difference between plans.	HDC reservoir would inundate the scenic Tsusena Falls loss of land use potential similar for both plans.	HDC/V plan results in a slightly greater loss of aesthetic and land use resources. The difference has a minor influence in the overall comparison of the plans.

TABLE 6 (Cont'd)

ENVIRONMENTAL IMPACTS ASSOCIATED WITH WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

River Reach	Environmental Attributes	Concerns	Difference in impact of two plans	Identification of difference	Appraisal Judgement
Watana to Vee Dam Site	Ecological	Loss of moose habitat.	Difference between plans.	Watana reservoir floods to elevation 2200' HDC reservoir floods to elevation 1750'. The lower reach of the Watana Creek basin, identified as an important moose area, would be inundated by the Watana reservoir. The quality of the habitat and condition of the subpopulation of moose in this area appears to be decreasing.	The Watana plan would create a greater impact on moose in this reach of the river however considering the declining nature of this moose habitat the significance of this impact is considered less than impacts that could occur upstream in the Vee reservoir.
		Impacts on Caribou migration.	Potential difference between plans.	Caribou crossing has been documented in Kosina/Jay Creek area. Due to the large winter drawdown and potential for ice shelving the Watana reservoir could inhibit caribou crossing in the spring. Although the HDC reservoir could have a similar effect the probability of impact is greater for the Watana reservoir.	The Watana plan could create a greater restriction on caribou crossing in this section of the river. The potential impact on caribou is compared with potential impacts upstream and considered to be less significant.
		Loss of river bottom and valley habitat.	Difference in river valley habitat lost.	The loss of river bottom habitat is similar for both schemes. Loss of forest along the valley slopes would be greater with the Watana scheme. This habitat has been identified as being important for birds and bears.	The Watana scheme would create a greater loss of important habitat along the valley slopes in this section of the river. This factor is considered of moderate importance in plan evaluation.
	Cultural	Loss of archeological sites.	No significant difference identified to date.	Due to the larger area of the Watana reservoir in this section, the probability of inundating archeological sites is increased.	Not a major factor in plan evaluation.
	Aesthetics/ Land Use	Resource agencies are concerned about creating access to extensive wilderness areas. On the other hand certain segments of the public desire improved access.	Location and extent of access could vary between plans.	More extensive road access would probably result from the HDC/V plan due to the construction requirements at Vee site. Access created directly by the reservoirs is similar for both schemes in this reach of the river.	Any Susitna development will increase access to this relatively wilderness area. As it is easier to extend access than to limit it, schemes with the least inherent access are considered superior. This is considered a moderate factor favoring the Watana scheme.
Vee dam site and upstream	Ecological	Inundation of resident fisheries.	Difference between plans.	The Vee reservoir maximum pool elevation is 2330'. The Watana reservoir maximum pool elevation is 2200'. The additional 130' elevation associated with the Vee dam would result in the inudation of approximately 12 additional miles of the Susitna River in this reach, 1-1/2 additional miles of the Oshetna River and 12 miles of the Tyone River.	The HDC/V plan results in a significant increase in the loss of resident fisheries habitat in this reach of the river.

TABLE 6 (Cont'd)

ENVIRONMENTAL IMPACTS ASSOCIATED WITH WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

River Reach	Environmental Attributes	Concerns	Difference in impact of two plans	Identification of difference	Appraisal Judgement
		Loss of moose habitat.	Significant difference between plans.	In addition to areas inundated by the Watana reservoir, the Vee impoundment would flood 20 additional miles of critical winter river bottom habitat in this reach utilized by at least three subpopulations of moose that range over large areas east of the Susitna and north of the MacLaren River reach.	The HDC/V plan would create a greater impact on moose in this section of the river. This impact on moose is judged to be of greater significance than the loss of moose habitat in the Watana Creek area resulting from the Watana reservoir.
		Impact on caribou migration.	Significant difference between plans.	Area flooded by HDC/V plan is historically used by Nelchina caribou herd. Due to increased length of river flooded the HDC/V plan would create a greater division of the Nelchina herd's range.	This potential negative effect on caribou is considered a major factor in the evaluation of the HDC/V plan.
		Impact of furbearers.	Difference between plans.	Area flooded by HDC/V plan considered important to some key furbearers, particularly red fox.	This furbearer loss is judged to be greater than furbearer losses associated with the inundation of the Watana Creek area.
	Cultural	Impact on archeological sites.	Potential difference between plans.	Preliminary studies indicate a high potential for discovery of archeological sites along lakes, streams and rivers in the easterly region of the Upper Susitna Basin. Additional sites are expected to be located near caribou crossing areas. The HDC/V plan has a greater probability of inundating potential sites.	The HDC/V plan is judged to have a greater potential for creating cultural impacts in this section of the river. This is considered a moderate factor in the evaluation of plans.
	Aesthetic/ Land Use	Loss of Vee Canyon.	No significant difference between plans.	With the HDC/V plan a dam would be situated in the lower reaches of the Vee canyon thus eliminating the existing aesthetic value of the canyon. With the W/DC plan the Vee canyon would be inundated to a depth of approximately 175'.	Not a factor in evaluation of plans.
		Access to wilderness areas.	Significant difference between plans.	In addition to the differences created by road access the formation of the Vee reservoir would open a large amount of the northeast section of the basin, an isolated area presently used extensively by caribou and moose.	Due to the possible impacts on caribou the access into this region created by the HDC/V plan considered a major negative factor associated with this plan.

NOTE: W = Watana dam
DC = Devil Canyon dam
HDC = High Devil Canyon dam
V = Vee dam

TABLE 7

ENVIRONMENTAL EVALUATION OF DEVIL CANYON DAM AND TUNNEL SCHEME

Environmental Attribute	Concerns	Appraisal (Differences in impact of two schemes)	Identification of difference	Appraisal Judgement	Scheme judged to have the least potential impact	
					Tunnel	DC
Ecological						
Downstream Fisheries and Wildlife	Effects resulting from changes in water quantity and quality.	No significant difference between schemes regarding effects downstream of Devil Canyon.		Not a factor in evaluation of scheme.		
		Difference in reach between Devil Canyon dam and tunnel re-regulation dam.	With the tunnel scheme controlled flows between regulation dam and downstream powerhouse offers potential for anadromous fisheries enhancement in this 11 mile reach of the river.	If fisheries enhancement opportunity can be realized the tunnel scheme offers a positive mitigation measure not available with the Devil Canyon dam scheme. This opportunity is considered moderate and favors the tunnel scheme.	X	
Resident Fisheries	Loss of resident fisheries habitat.	Minimal differences between schemes.	Devil Canyon dam would inundate 27 miles of the Susitna River and approximately 2 miles of Devil Creek. The tunnel scheme would inundate 16 miles of the Susitna River.	This reach of river is not considered to be highly significant for resident fisheries and thus the difference between the schemes is minor and favors the tunnel scheme.	X	
Wildlife	Loss of wildlife habitat.	Minimal differences between schemes.	The most sensitive wildlife habitat in this reach is upstream of the tunnel re-regulation dam where there is no significant difference between the schemes. The Devil Canyon dam scheme in addition inundates the river valley between the two dam sites resulting in a moderate increase in impacts to wildlife.	The difference in loss of wildlife habitat is considered moderate and favors the tunnel scheme.	X	
Cultural	Inundation of archeological sites.	Potential differences between schemes.	Due to the larger area inundated the probability of inundating archeological sites is increased.	No significant sites have been identified. If discovered mitigation measures are easily implemented. Therefore this concern is not considered a factor in scheme evaluation.	-	-
Aesthetic/ Land Use	Inundation of Devil Canyon.	Significant difference between schemes.	The Devil Canyon is considered a unique resource, 80 percent of which would be inundated by the Devil Canyon dam scheme. This would result in a loss of both an aesthetic value plus the potential for white water recreation.	The aesthetic and to some extent the recreational losses associated with the development of the High Devil Canyon dam is the main aspect favoring the tunnel scheme.	X	

OVERALL EVALUATION: The tunnel scheme has overall a lower impact on the environment.

TABLE 8 - Social Evaluation of Susitna Basin Development Schemes/Plans

Social Aspect	Parameter	Tunnel Scheme	Devil Canyon Dam Scheme	High Devil Canyon/ Vee Plan	Watana/Devil Canyon Plan	Remarks
Potential non-renewable resource displacement	Million tons Beluga coal, over 50 years	80	110	170	210	Devil Canyon dam scheme potential higher than tunnel scheme. Watana/ Devil Canyon plan higher than High Devil Canyon/ Vee plan.
Impact on State economy	--	All projects would have similar impacts on the state and local economy.				Essentially no difference between plans/schemes.
Impact on local economy	--					
Seismic exposure	Risk of major structural failure	All projects designed to similar levels of safety.				
	Potential impact of failure on human life	Any dam failures would effect the same downstream population.				

Overall Evaluation

1. Devil Canyon dam superior to tunnel.
2. Watana/Devil Canyon superior to High Devil Canyon/Vee plan.

TABLE 9

ENERGY CONTRIBUTION EVALUATION OF THE DEVIL CANYON DAM AND TUNNEL SCHEMES

Parameter	Devil Canyon	Tunnel	Remarks
Total Energy Production Capability			
Annual Average Energy GWH	2850	2240	Devil Canyon dam annually developes 610 GWH and 540 GWH more average and firm energy respectively than the the Tunnel scheme.
Firm Annual Energy GWH	2590	2050	
% Basin Potential Developed (1)	43	32	Devil Canyon schemes develops more of the basin potential
Energy Potential Not Developed GWH	60	380	As currently envisaged, the Devil Canyon dam does not develop 15 ft gross head between the Watana site and the Devil Canyon reservoir. The tunnel scheme incorporates additional friction losses in tunnels. Also the compensation flow released from re-regulation dam is not used in conjunction with head between re-regulation dam and Devil Canyon.

Notes: (1) Based on annual average energy. Full potential based on USBR four dam scheme (Reference ________).

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TABLE 10 - OVERALL EVALUATION OF TUNNEL SCHEME AND DEVIL CANYON DAM SCHEME

ATTRIBUTE	SUPERIOR SCHEME
ECONOMIC	DEVIL CANYON DAM
ENERGY CONTRIBUTION	DEVIL CANYON DAM
ENVIRONMENTAL	TUNNEL
SOCIAL	DEVIL CANYON DAM (MARGINAL)
OVERALL EVALUATION	DEVIL CANYON DAM SCHEME IS SUPERIOR TRADE OFFS MADE: ECONOMIC ADVANTAGE OF DAM SCHEME IS JUDGED TO OUTWEIGH THE REDUCED ENVIRONMENTAL IMPACT ASSOCIATED WITH THE TUNNEL SCHEME.

TABLE 11

ENVIRONMENTAL EVALUATION OF WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

Environmental Attribute	Plan Comparison	Appraisal Judgement	Plan judged to have the least potential impact HDC/V	W/DC
Ecological 1) Fisheries	No significant difference in effects on downstream anadromous fisheries. HDC/V would inundate approximately 95 miles of the Susitna River and 28 miles of tributary streams, including the Tyone River. W/DC would inundate approximately 84 miles of the Susitna River and 24 miles of tributary streams, including Watana Creek.	Due to the avoidance of the Tyone River, lesser inundation of resident fisheries habitat and no significant difference in the effects on anadromous fisheries, the W/DC plan is judged to have less impact.		X
2) Wildlife a) Moose	HDC/V would inundate 123 miles of critical winter river bottom habitat. W/DC would inundate 108 miles of this river bottom habitat. HDC/V would inundate a large area upstream of Vee utilized by three sub-populations of moose that range of large areas of the northeast section of the basin. W/DC would inundate the Watana Creek area utilized by moose. The condition of this sub-population of moose and the quality of the habitat they are using appears to be decreasing.	Due to the lower potential for direct impact on moose populations within the Susitna, the W/DC plan is judged superior.		X
b) Caribou	The increased length of river flooded, especially upstream from the Vee dam site, would result in the HDC/V plan creating a greater potential division of the Nelchina herd's range. In addition, an increase in range would be directly inundated by the Vee reservoir.	Due to the potential for a greater impact on the Nelchina caribou herd, the HDC/V scheme is considered inferior.		X
c) Furbearers	The area flooded by the Vee reservoir is considered important to some key furbearers, particularly red fox. This area is judged to be more important than the Watana Creek area that would be inundated by the W/DC plan.	Due to the lesser potential for impact on furbearers the W/DC is judged to be superior.		X
d) Birds and Bears	Forest habitat, important for birds and bears, exists along the valley slopes. The loss of this habitat would be greater with the W/DC plan.	The HDC/V plan is judged superior.	X	
Cultural	There is a high potential for discovery of archeological sites in the easterly region of the Upper Susitna Basin. The HDC/V plan has a greater potential of affecting these sites. For other reaches of the river the difference between plans is considered minimal.	The W/DC plan is judged to have a lower potential effect on archeological sites.		X

TABLE 11

ENVIRONMENTAL EVALUATION OF WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE DEVELOPMENT PLANS

Environmental Attribute	Plan Comparison	Appraisal Judgement	Plan judged to have the least potential impact HDC/V	W/DC
Aesthetic/ Land Use	With either scheme, the aesthetic quality of both Devil Canyon and Vee Canyon would be impaired. The HDC/V plan would also inundate Tsusena Falls.	Both plans impact the valley aesthetics. The difference is considered minimal.	-	-
	Due to construction at Vee Dam site and the size of the Vee Reservoir, the HDC/V plan would inherently create access to more wilderness area than would the W/DC plan.	As it is easier to extend access than to limit it, inherent access requirements were considered detrimental and the W/DC plan is judged superior. The ecological sensitivity of the area opened by the HDC/V plan reinforces this judgement.		X
		Due to the lower potential for direct impact on moose populations within the Susitna, the W/DC plan is judged superior.		X

OVERALL EVALUATION: The W/DC plan is judged to be superior to the HDC/V plan.
(The lower impact on birds and bears associated with HDC/V plan is considered to be outweighed by all the other impacts which favour the W/DC plan.)

NOTE:
W = Watana Dam
DC = Devil Canyon Dam
HDC = High Devil Canyon Dam
V = Vee Dam

TABLE 12

ENERGY CONTRIBUTION EVALUATION OF THE WATANA/DEVIL CANYON AND HIGH DEVIL CANYON/VEE PLANS

Parameter	Watana/ Devil Canyon	High Devil Canyon/Vee	Remarks
Total Energy Production Capability			
Annual Average Energy GWH	6070	4910	Watana/Devil Canyon plan annually develeopes 1160 GWH and 1650 GWH more average and firm energy repectively than the High Devil Canyon/Vee Plan.
Firm Annual Energy GWH	5520	3870	
% Basin Potential Developed (1)	91	81	Watana/Devil Canyon plan develops more of the basin potential
Energy Potential Not Developed GWH (2)	60	650	As currently conceived, the Watana/Devil Canyon Plan does not develop 15 ft of gross head between the Watana site and the Devil Canyon reservoir. The High Devil Canyon/Vee Plan does not develop 175 ft gross head between Vee site and High Devil reservoir.

Notes: (1) Based on annual average energy. Full potential based on USBR four dam scheme (Reference ________).
(2) Includes losses due to unutilized head.

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TABLE 13 - OVERALL EVALUATION OF THE HIGH DEVIL CANYON/VEE AND WATANA/DEVIL CANYON DAM PLANS

ATTRIBUTE	SUPERIOR PLAN
ECONOMIC	WATANA/DEVIL CANYON
ENERGY CONTRIBUTION	WATANA/DEVIL CANYON
ENVIRONMENTAL	WATANA/DEVIL CANYON
SOCIAL	WATANA/DEVIL CANYON (MARGINAL)

OVERALL EVALUATION	PLAN WITH WATANA/DEVIL CANYON IS SUPERIOR
	<u>TRADEOFFS MADE</u>: NONE

TABLE 14

ECONOMIC SENSITIVITY OF COMPARISON OF GENERATION PLAN WITH WATANA/DEVIL CANYON AND THE ALL THERMAL PLAN

Present worth of Net Benefit ($ million) of total generation system costs for the Watana/Devil Canyon plan over the all thermal plan.

Parameters		Present worth ($ million)	Remarks
ECONOMIC EVALUATION: Base Case		2280	Watana/Devil Canyon plan more economical than the all thermal plan.
SENSITIVITY ANALYSES: Parameter	Sensitivity Analyses		
LOAD GROWTH	Low LHC Low High	1280 1570 2840	The net benefit of the Watana/Devil Canyon Plan remains positive for the range of load forecasts considered.
CAPITAL COST ESTIMATE	Low Thermal Cost* High Hydroelectric Cost**	1850 1320	System costs relatively insensitive. Capital cost estimating uncertainty does not effect economic ranking.
PERIOD OF ECONOMIC ANALYSIS	Period shortened to (1980 - 2010)	2280 960	Shorter period of evaluation decreases economic differences. Ranking remains unchanged.
DISCOUNT RATE	5% 8% (interpolated) 9%	940 0 -80	Below discount rate of 8% the Watana/Devil Canyon plan is economically superior.
FUEL COST	Low***	1810	
FUEL COST ESCALATION	0% escalation for all fuels 0% escalation for coal only	200 1330	Watana/Devil Canyon plan remains economically superior for wide range of fuel prices and escalation rates.
ECONOMIC THERMAL PLANT LIFE	50% extension to all thermal plant life	1800	Economic benefit for Watana/Devil Canyon plan relatively insensitive to extended thermal plan economic life.

*Thermal capital cost decreased by 22%
**Based on estimated Susitna cost plus 50%
***Fuel Costs reduced by 20%

TABLE 15 - Social Comparison of System Generation Plan with Watana/Devil Canyon and the All Thermal Plan

Social Aspect	Parameter	All Thermal Generation Plan	Generation Plan with Watana/Devil Canyon	Remarks
Potential non-renewable resource displacement	Million tons of Beluga coal, over 50 years	--	210	With Watana/Devil Canyon plan is superior.
Impact on state economy Impact on local economy	Direct & indirect employment and income. Business investment.	Gradually, continuously growing impact.	Potentially more disruptive impact on economics.	
Seismic exposure	Risk of major structural failure	All projects designed to similar levels of safety		
	Potential impact of failure on human life	Failure would effect only operating personnel. Forecast of failure would be impossible	Failure would effect larger number of people located downstream, however, some degree of forecasting dam failure would be impossible	
Overall Comparison	Inconclusive			

TABLE 16

GENERIC COMPARISON OF ENVIRONMENTAL IMPACTS OF A SUSITNA BASIN HYDRO DEVELOPMENT VERSUS COAL FIRED THERMAL GENERATION IN THE BELUGA COALFIELDS

Environmental Attributes	Concerns	
	Susitna Basin Development	Thermal Generation
Ecological:	Potential impact on fisheries due to alteration of downstream flow distribution and water quality. Inundation of Moose and furbear habitat and potential impact on Caribou migration. No major air quality problems, only minor microclimatic changes would occur.	Potential for impact on fisheries resulting from water quality impairment of local streams and local habitat destruction due to surface disturbances both at mine and generating facilities. Impact on air quality due to emission of particulates SO_2, NO_x, trace metals and water vapours from generating facilities.
Cultural:	Inundation of archeological sites.	Potential destruction of archeological sites.
Aethetic/ Land Use:	Inundation of large area and surface disturbance in construction area. Creates additional access to wilderness areas, reduces river recreation but increases lake recreational activities.	Surface disturbance of large areas associated with coal mining and thermal generation facilities. Creates additional access and may restrict land use activities.

TABLE 17 - OVERALL EVALUATION OF ALL THERMAL GENERATION PLANS WITH THE GENERATION PLAN INCORPORATING WATANA/DEVIL CANYON DAMS

ATTRIBUTE	SUPERIOR PLAN
ECONOMIC	WITH WATANA/DEVIL CANYON
ENERGY CONTRIBUTION	NO DIFFERENCE
ENVIRONMENTAL	UNABLE TO DISTINGUISH DIFFERENCE IN THIS STUDY
SOCIAL	NO DIFFERENCE
OVERALL EVALUATION	PLAN WITH WATANA/DEVIL CANYON IS SUPERIOR TRADEOFFS MADE: NOT FULLY EXPLORED

APPENDIX - SYSTEM GENERATION PLANS BACKUP INFORMATION AND SUMMARY TABLES

TABLE I.

SALIENT FEATURES OF GENERATION PLANNING PROGRAMS

Program/ Developer	Load Modeling	Generation Modeling	Optimization Available	Reliability Criterion	Production Simulation	Availability and Cost/Run
GENOP/ Westinghouse	Done by two external programs	Done by one external program	yes	LOLP or % reserve	Deterministic or Modified Booth - Baleriaux	$500 to validate Learning Curve Costs $300 - $800/run
PROMOD/EMA	Done by one external program	Done by one external program	no	LOLP or % reserve	Modified Booth - Baleriaux	$2,500 to validate on TYMSHARE Learning Curve Costs $300 - $500/run
OGP/GE	Done by one external program	Done by one external program	yes	LOLP or % reserve	Deterministic or Stochastic	AAI validated Columbia & Buffalo Experienced Personnel $50 - $800/run

TABLE 2

LOAD AND ENERGY FORECASTS* ALASKA RAILBELT AREA

YEAR	Low Forecast		Mid Forecast		High Forecast	
	MW	GWh	MW	GWh	MW	GWh
1980 BASE	514	2,789	514	2,789	514	2,789
1985	578	3,158	650	3,565	695	3,859
1990	641	3,503	735	4,032	920	5,085
1995	797	4,351	944	5,171	1,294	7,119
2000	952	5,198	1,173	6,413	1,669	9,153
2005	1,047	5,707	1,379	7,526	2,287	12,543
2010	1,141	6,215	1,635	8,938	2,209	15,933

* Derived from the Woodward-Clyde Consultants submittal of September 23, 1980, adjusted to eliminate industrial self-supplied and two-thirds of the military sector.

TABLE . 3

ANNUAL FIXED CARRYING CHARGES
USED IN GENERATION PLANNING MODEL

	Project Life/Type			
	30-Year Thermal (%)	35-Year Thermal (%)	50-Year Hydro (%)	20-Year Thermal (%)
ECONOMIC PARAMETERS (0%-3%)				
Cost of Money	3.00	3.00	3.00	3.00
Amortization	2.10	1.65	0.89	3.72
Insurance	0.25	0.25	0.10	0.25
TOTALS	5.35	4.90	3.99	6.97

TABLE 4

FUEL PRICES AND ESCALATION RATES

	Natural Gas	Coal	Distillate
Base Period (January 1980) Prices ($/million Btu)			
Market Prices	$1.05	$1.15	$4.00
Shadow (Opportunity) Values	2.00	1.15	4.00
Real Escalation Rates (Percentage Change Compounded Annually)			
1980 - 1985	1.79%	9.56%	3.38%
1986 - 1990	6.20	2.39	3.09
1991 - 1995	3.99	-2.87	4.27
Composite (average) 1980 - 1995	3.98	2.93	3.58
1996 - 2005	3.98	2.93	3.58
2006 - 2010	0	0	0

TABLE 5.

SUMMARY OF ECONOMIC PARAMETERS FOR GENERATION PLANNING

1 - Base Period (January 1980)	
Energy Prices ($/million Btu)	
1.1 - Natural Gas	2.00
1.2 - Coal	1.15
1.3 - Distillate	4.00
2 - General Price Inflation Per Year (%)	not applicable
3 - Discount & Interest Rates Per Year (%)	
3.1 - Real Discount Rate	3
3.2 - Nominal Interest Rate (Non-exempt Case)	not applicable
3.3 - Nominal Interest Rate (Tax-exempt Case)	not applicable
4 - Non-energy Cost Escalation Per Year (%)	0
5 - Energy Price Escalation Per Year (%)	
5.1 - Natural Gas	
1980 - 2005	3.98
2006 - 2010	0
5.2 - Coal	
1980 - 2005	2.93
2006 - 2010	0
5.3 - Distillate	
1980 - 2005	3.58
2006 - 2010	0
6 - Economic Life (Years)	
6.1 - Large Steam Turbine	30
6.2 - Small Steam Turbine	35
6.3 - Hydro	50
6.4 - Diesel and Gas Turbine (Gas-fired)	30
6.5 - Gas Turbine (Oil-fired)	20

TABLE 6 TEN YEAR BASE GENERATION PLAN MID LOAD FORECAST

YEAR	MW Committed	MW Retired	SYSTEM (MW) COAL	NG GT	OIL GT	OIL DIESEL	CC	HY	TOTAL CAPABILITY (MW)
1980	-	-	54	470	168	65	141	49	947*
1981	-	-	54	470	168	65	141	49	947
1982	60 CC	-	54	470	168	65	201	49	1007
1983	-	-	54	470	168	65	201	49	1007
1984	-	-	54	470	168	65	201	49	1007
1985	-	14 (NGGT)	54	456	168	65	201	49	993
1986	-	-	50	456	168	65	201	49	993
1987	-	4 (Coal)	50	456	168	65	201	49	989
1988	95 HY	-	50	456	168	65	201	144	1084
1989	-	5 (Coal)	45	456	168	65	201	144	1079
1990	-	-	45	456	168	65	201	144	1079

*This figures varies slightly from the 943.6 MW reported due to internal computer rounding.

TABLE 7 SUSITNA BASIN HYDROELECTRIC ALTERNATIVES

Plan	Stage	Description	On-line Month/Year	Construction Period (Yrs)	Total Cost* Million 1980$		Installed Capacity	Peak Month Firm Capacity
E1.2	1	Watana Low Dam	1/92	8	1774		400 MW	206 MW
	2	Raise Watana Dam	1/95	3	376			194 MW
	3	Add Capacity	1/97	3	136		400 MW	400 MW
	4	Devil Canyon Dam	1/02	7	999		400 MW	352 MW
						TOTAL	1200 MW	1152 MW
E1.3	1	High Watana Dam	6/93	9	1984		400 MW	400 MW
	2	Add powerhouse capacity	1/96	3	157		400 MW	400 MW
	3	Devil Canyon Dam	1/00	7	999		400 MW	352 MW
						TOTAL	1200 MW	1152 MW
–	1	Watana High Dam	6/93	9	1984		400 MW	400 MW
	2	Devil Canyon Dam	1/00	7	999		400 MW	337 MW
						TOTAL	800 MW	737 MW
–	1	High Devil Canyon Dam	1/94	8	1570		400 MW	351 MW
	2	Vee Dam	1/00	7	1177		400 MW	315 MW
						TOTAL	800 MW	666 MW
1.5	1	Watana High Dam	6/93	9	1984		400 MW	400 MW
	2	Add powerhouse capacity	1/96	3	157		400 MW	400 MW
	3	Add tunnel capacity	1/00	5	1615		380 MW	194 MW
						TOTAL	1180 MW	994 MW
Comp. Hydro	1	Chakachamna	1/93	10	1201		500 MW	500 MW
	2	Keetna	1/97	8	463		120 MW	77 MW
	3	Snow	1/02	6	223		50 MW	22 MW
						TOTAL	670 MW	599 MW

*Includes Interest During Construction (IDC) But excludes cost of reregulation dams

** Two tunnel scheme

TABLE 8 SUMMARY OF BASE GENERATION PLANS - MID LOAD FORECAST - 1200MW SUSITNA ALTERNATIVES

PARAMETER / JOB I.D.#	SUSITNA ALTERNATIVES				
	W/DC 1.2 L5Y9	W/DC E1.3 L8J9	HDC/VEE E2.3 L601	HDC/CC LEB3	W/T** 1.5 L607
1990 MW	1079 MW	1079 MW	1079 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:					
Coal (MW)	200	300	300	300	200
NGGT (MW)	300	225	450	525	450
Diesels (MW)	0	0	20	220	30
TOTAL	500 MW	525 MW	770 MW	1045 MW	680 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	1/92 W400 1/95 + Dam 1/97 W400 1/02 DC400	6/93 W400 1/96 W400 1/00 DC400	6/93 HDC400 1/96 HDC400 1/00 VEE400	6/93 HDC400 1/96 HDC400 1/00 CC500	6/93 W400 1/96 W400 1/00 T380
TOTAL FIRM* (2010)	1997 MW	2023 MW	2230 MW	2690 MW	2034 MW
$\$ \times 10^6$ (80$)					
10 Year PW	$ 873.7	$ 873.7	$ 873.7	$ 873.7	$ 873.7
20 Year PW	2509.4	2360.6	2487.8	2624.5	2591.0
TOTAL	$3383.1	$3234.3	$3361.5	$3273.2	$3464.7
LONG TERM (2040) PW	$6028	$5851	$6372	$6209	$6528

*In Peak Month (December)

** Two tunnel scheme

TABLE 9 SUMMARY OF GENERATION PLANS - MID LOAD FORECAST - 800 MW SUSITNA ALTERNATIVES

	SUSITNA ALTERNATIVES			
	W800	HDC800	W400/DC400	HDC/Vee
PARAMETERS / JOB I.D.#	L7W7	LE07	LCK5	LB25
1990 MW	1079 MW	1079 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:				
Coal (MW)	500	500	200	400
NGGT (MW)	450	450	525	450
Diesels (MW)	-	30	50	60
TOTAL	950 MW	980 MW	775 MW	910 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)
HYDRO ADDS:				
MONTH/YEAR NAME MW	6/93 W400 1/96 W400	6/93 HDC400 1/96 HDC400	6/93 W400 1/00 DC400	1/94 HDC 400 1/00 VEE 400
TOTAL FIRM* ~~MW~~ (2010)	2095 MW	2125 MW	1858 MW	1921 MW
$\$ \times 10^6$ (80$)				
10 year PW	$ 873.7	$ 873.7	$ 873.7	$ 873.7
20 year PW	2765.1	2628.0	2349.6	2624.5
TOTAL	$ 3638.8	$ 3501.7	$ 3223.3	$ 3498.2
LONG TERM (2040) PW	$ 6955	$ 6715	$ 5891	$ 6620

* In peak month - December

ALTERNATIVE

TABLE 10 SUMMARY OF BASE GENERATION PLANS - MID LOAD FORECAST

PARAMETER / JOB I.D.#	THERMAL RENEWS LME3	THERMAL NO RENEWS LME1	THERMAL AND OTHER HYDRO LFL7
1990 MW	1079 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:	456 RN**		
Coal (MW)	900	900	700
NGGT (MW)	150	600	300
Diesels (MW)	40	50	10
TOTAL	1546 MW	1550 MW	1010 MW
RETIREMENTS (MW)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	-	1/93 Chaka 500 1/97 Keetna 120 1/02 Snow 50
TOTAL FIRM* MW (2010)	1891 MW	1895 MW	1954 MW
$ x 10^6 (80$)			
10 Year PW	$ 873.7	$ 873.7	$ 873.7
20 Year PW	3308.3	3319.4	2802.2
TOTAL	$4182.0	$4193.1	$3675.9
LONG TERM (2040) PW	$8109	$8133	$7038

added [illegible]

*In Peak Month (December)
**RN - renews

TABLE 11 SUMMARY OF SUSITNA GENERATION PLANS - HIGH LOAD FORECAST

PARAMETER / JOB I.D.#	SUSITNA ALTERNATIVES 3AE LA73	HDC/VEE LBV3	HDC/VEE/CC LBY1	W/W/DC/CC LBV7
1990 MW (+100 MW COAL)	1179 MW	1179 MW	1179 MW	1179 MW
1990-2010 THERMAL ADDS:				
Coal (MW)	900	1200	900	700
NGGT (MW)	750	750	675	450
Diesels (MW)	-	90	10	60
TOTAL	1650 MW	2040 MW	1585 MW	1210 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	6/93 W400 1/96 W400 1/00 DC400	6/93 HDC400 1/96 HDC400 1/00 VEE400	6/93 HDC400 1/96 HDC400 1/00 VEE400 1/03 CC500	6/93 W400 1/96 W400 1/00 DC400 1/05 CC500
TOTAL FIRM* ~~MW~~ (2010)	3248 MW	3600 MW	3645 MW	3308 MW
$\$ \times 10^6$ (80\$)				
10 year PW	\$ 1060.5	\$ 1060.5	\$ 1060.5	\$ 1060.5
20 year PW	4094.6	4462.4	4252.9	3946.3
TOTAL	\$ 5155.1	\$ 5522.9	\$ 5313.4	\$ 5006.8
LONG TERM (2040) PW	\$10,678	\$11,719	\$11,037	\$10,048

*In peak month - December
~~**RN - renews~~

TABLE 12 SUMMARY OF SUSITNA GENERATION PLANS - LOW LOAD FORECAST

PARAMETER / JOB I.D. #	SUSITNA ALTERNATIVES				
	W400/DC400 LC07	HDC/VEE LGO ?	HDC400 LBU1	W400 LBK7	W400/T** L609
1990 MW	1079MW	1079MW	1079MW	1079MW	1079MW
1990-2010 THERMAL ADDS:					
Coal (MW)	-	100	400	200	--
NGGT (MW)	150	225	300	300	375
Diesels (MW)	40	30	-	80	20
TOTAL	190MW	355MW	700MW	580MW	395MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	6/93 W400 1/02 DC400	6/93 HDC400 1/02 VEE400	6/93 HDC400	6/93 W400	6/93 W400 1/02 T380
TOTAL FIRM* (2010)	1272MW	1367MW	1396MW	1325MW	1319MW
$ x 10^6 (80$)					
10 year PW	$ 744.1	$ 744.1	$ 744.1	$ 744.1	$ 744.1
20 year PW	1835.8	1894.9	1961.6	2029.7	2048.5
TOTAL	$ 2579.9	$ 2639.0	$2705.7	$2773.8	$2792.6
LONG TERM (2040) PW	$ 4350	$ 4557	$4852	$4940	$4997

*In peak month - December

** Two tunnel scheme

TABLE 13 SUMMARY OF GENERATION PLANS - LOAD MANAGEMENT AND CONSERVATION FORECAST

PARAMETER / JOB I.D.#	THERMAL NO RENEWS LBT7	SUSITNA W400/D400 L7B7
1990 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:		
Coal (MW)	500	-
NGGT (MW)	225	450
Diesels (MW)	90	50
TOTAL	815 MW	500 MW
RETIREMENTS (MW)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	1/97 W400 1/05 DC400
TOTAL FIRM* MW 2010	1160 MW	1582 MW
$\$ \times 10^6$ (80$)		
10 year PW	$ 721.9	$ 721.9
20 year PW	2034.3	1556.0
TOTAL	$ 2756.2	$ 2277.9
LONG TERM (2040) PW	$ 4931	$ 3648

*In peak month - December

TABLE 14. SUMMARY OF GENERATION PLANS - PROBABILISTIC LOAD FORECAST

PARAMETER / JOB I.D.#	THERMAL NO RENEWS LOF3	SUSITNA 3AE L8T5
1990 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:		
Coal (MW)	1100	200
NGGT (MW)	1575	1275
Diesels (MW)	100	140
TOTAL	2775 MW	1615 MW
RETIREMENTS (MW)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	6/93 W400 1/96 W400 1/02 DC400
TOTAL FIRM* MW 2010	3120 MW	3112 MW
$\$ \times 10^6$ (80$)		
10 year PW	$ 873.7	$ 873.7
20 year PW	3353.6	2546.5
TOTAL	$4227.3	$3420.2
LONG TERM (2040) PW	$8324	$6292

*In peak month - December

TABLE 15 INPUT PARAMETERS - INTEREST RATE SENSITIVITY

Input Variable	Interest Rates 3 Percent	5 Percent	9 Percent
Annual Fixed Carrying Charges (%)			
30 Year Thermal	5.35%	6.75%	9.98%
20 Year Thermal	6.97	8.27	11.20
50 Year Hydro	3.99	5.58	9.37
Total Capital Costs ($ x 10^6)			
250 MW Coal	$ 686	$ 727	$ 815
75 MW NGGT	26	26.3	27
10 MW Diesel	10	10.3	10.4
1 - Watana 400	$ 1984	$ 2175	$ 2589
2 - Watana 400	157	161	168
3 - Devil Canyon 400	999	1069	1224

TABLE 16 SENSITIVITY ANALYSIS - INTEREST RATES

	THERMAL			SUSITNA - 3AE		
	BASECASE	SENSITIVITY		BASECASE	SENSITIVITY	
PARAMETER / JOB I.D.#	LME1	LEA9	LEB1	L8J9	LF85	LF87
ESCALATION/ INTEREST RATE	0% - 3%	0% - 5%	0% - 9%	0% - 3%	0% - 5%	0% - 9%
1990-2010 THERMAL ADDS:						
Coal (MW)	900	900	900	300	300	300
NGGT (MW)	600	600	600	225	225	225
Diesels (MW)	50	50	50	-	-	-
TOTAL	1550 MW	1550 MW	1550 MW	525 MW	525 MW	525 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	-	-	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400
TOTAL FIRM* MW 2010	1895 MW	1895MW	1895 MW	2023 MW	2023 MW	2023 MW
$ x 10^6 (80$)						
10 Year PW	$ 873.7	$ 791.1	$ 714.8	$ 873.7	$ 791.1	$ 714.8
20 Year PW	3319.4	2441.7	1367.2	2360.6	1977.3	1469.2
TOTAL	$4193.1	$3232.8	$2082.0	$3234.3	$2768.4	$2184.0
LONG TERM (2040) PW	$8133	$5172	$2609	$5851	$4226	$2691

*In Peak Month (December)

TABLE 17. SENSITIVITY ANALYSIS - FUEL COSTS

PARAMETER / JOB I.D.#	THERMAL BASECASE LME1	THERMAL SENSITIVITY L1K7	SUSITNA - 3AE BASECASE L8J9	SUSITNA - 3AE SENSITIVITY L533
FUEL COST ($/MMBTU)				
Coal	$1.15	$0.92	$1.15	$0.92
Natural Gas	$2.00	$1.60	$2.00	$1.60
Oil	$4.00	$3.20	$4.00	$3.20
1990-2010 THERMAL ADDS:				
Coal (MW)	900	800	300	100
NGGT (MW)	600	675	225	375
Diesels (MW)	50	70	-	20
TOTAL	1550 MW	1545 MW	525 MW	495 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)
HYDRO ADDS:				
MONTH/YEAR NAME MW	-	-	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400
TOTAL FIRM* MW 2010	1895 MW	1890 MW	2023 MW	1993 MW
$ x 10^6 (80$)				
10 year PW	$ 873.7	$ 716.5	$ 873.7	$ 716.5
20 year PW	3319.4	2880.0	2360.6	2145.2
TOTAL	$4193.1	$3596.5	$3234.3	$2861.7
LONG TERM (2040) PW	$8133	$7072	$5851	$5260

* In Peak Month (December)

NOTE: Sensitivity analysis performed using 0% escalation, 3% interest rate and the midload forecast.

TABLE : 18 SENSITIVITY ANALYSIS - FUEL COST ESCALATION

PARAMETER / JOB I.D.#	THERMAL BASECASE LME1	THERMAL SENSITIVITY L547	THERMAL SENSITIVITY L561	SUSITNA - 3AE BASECASE L8J9	SUSITNA - 3AE SENSITIVITY L557	SUSITNA - 3AE SENSITIVITY L563
FUEL COST ESCALATION RATES (%)						
Natural Gas	3.98%	0%	3.98%	3.98%	0%	3.98%
Coal	2.93%	0%	0%	2.93%	0%	0%
Oil	3.58%	0%	3.58%	3.58%	0%	3.58%
1990-2010 THERMAL ADDS:						
Coal (MW)	900	-	1100	300	-	300
NGGT (MW)	600	1500	525	225	450	225
Diesels (MW)	50	10	10	-	30	-
TOTAL	1550 MW	1510 MW	1635 MW	525 MW	480 MW	525 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	-	-	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400
TOTAL FIRM* MW 2010	1895 MW	1855 MW	1980 MW	2023 MW	1978 MW	2023 MW
$\$ \times 10^6$ (80\$)						
10 year PW	\$ 873.7	\$ 721.8	\$ 865.4	\$ 873.7	\$ 721.8	\$ 865.4
20 year PW	3319.4	1835.0	2854.6	2360.6	1806.4	2307.1
TOTAL	\$4193.1	\$2556.8	\$3720.0	\$3234.3	\$2528.2	\$3172.5
LONG TERM (2040) PW	\$8133	\$4558	\$6916	\$5851	\$4357	\$5586

* In Peak Month (December)

NOTE: Sensitivity analysis performed using 0% escalation, 3% interest rate and the mid load forecast.

TABLE 19 SENSITIVITY ANALYSIS - THERMAL PLANT RETIREMENT POLICY

	THERMAL		SUSITNA - 3AE	
PARAMETER / JOB I.D.#	BASECASE LME1	SENSITIVITY L583	BASECASE L8J9	SENSITIVITY L585
RETIREMENT POLICY (YRS.)				
Coal-fired Steam	30 Yrs	45 Yrs	30 Yrs	45 Yrs
Natural Gas GT	30 Yrs	45 Yrs	30 Yrs	45 Yrs
Oil GT	20 Yrs	30 Yrs	20 Yrs	30 Yrs
1990-2010 THERMAL ADDS:				
Coal (MW)	900	1100	300	-
NGGT (MW)	600	75	225	-
Diesels (MW)	50	-	-	-
TOTAL	1550 MW	1175 MW	525 MW	0 MW
RETIREMENTS (MW)	(734)	(290)	(734)	(290)
HYDRO ADDS:				
MONTH/YEAR NAME MW	-	-	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400
TOTAL FIRM* MW 2010	1895 MW	1973 MW	2023 MW	1951 MW
$ x 10^6 (80$)				
10 year PW	$ 873.7	$ 873.7	$ 873.7	$ 873.7
20 year PW	3319.4	3318.3	2360.6	2382.7
TOTAL	$4193.1	$4192.0	$3234.3	$3256.4
LONG TERM (2040) PW	$8133	$7850	$5851	$6100

* In Peak Month (December)

NOTE: Sensitivity analysis performed using 0% escalation, 3% interest rate and the midload forecast.

TABLE. 20 SENSITIVITY ANALYSIS - THERMAL PLANT CAPITAL COSTS (1980$)

PARAMETER / JOB I.D.#	THERMAL BASECASE LME1	THERMAL SENSITIVITY LAL9	SUSITNA - 3AE BASECASE L8J9	SUSITNA - 3AE SENSITIVITY LED7
THERMAL PLANT CAPITAL COSTS ($/kW)				
Coal-fired Steam (250 MW)	$2744/kW[1]	$2135/kW[2]	$2744/kW[1]	$2135/kW[2]
Natural Gas GT (75 MW)	350/kW	350/kW	350/kW	350/kW
Diesels (10 MW)	778/kW	778/kW	778/kW	778/kW
1990-2010 THERMAL ADDS:				
Coal (MW)	900	1100	300	300
NGGT (MW)	600	525	225	225
Diesels (MW)	50	10	-	-
TOTAL	1550 MW	1635 MW	525 MW	525 MW
RETIREMENTS (MW)	(734)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	-	-	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400
TOTAL FIRM* MW 2010	1895 MW	1980 MW	2023 MW	2023 MW
$ x 10^6 (80$)				
10 year PW	$ 873.7	$ 873.7	$ 873.7	$ 873.7
20 year PW	3319.4	3095.3	2360.6	2344.6
TOTAL	$4193.1	$3969.0	$3234.3	$3218.3
LONG TERM (2040) PW	$8133	$7585	$5851	$5744

*In Peak Month (December)

NOTE: Sensitivity analysis performed using 0% excalation, 3% interest rate and the mid load forecast.

[1] 1.8 Alaskan Adjustment Factor

[2] 1.4 Alaskan Adjustment Factor

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TABLE 21 SENSITIVITY ANALYSIS - WATANA/DEVIL CANYON CAPITAL COSTS (1980$)

PARAMETER / JOB I.D.#	BASECASE L8J9	SUSITNA - SENSITIVITY L5G1	SUSITNA - SENSITIVITY LD75
SUSITNA COST ($x10^6) (80$)			
Watana Dam	$1984	$1984	$2976
Devil Canyon Dam	999	1110	1498
Tunnel	-	-	-
1990-2010 THERMAL ADDS:			
Coal (MW)	300	300	300
NGGT (MW)	225	225	225
Diesels (MW)	-	-	-
TOTAL	525 MW	525 MW	525 MW
RETIREMENTS (MW)	(734)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400 1/00 DC400	6/93 W400 1/96 W400
TOTAL FIRM* MW 2010	2023 MW	2023 MW	2023 MW
$ x 10^6 (80$)			
10 year PW	$ 873.7	$ 873.7	$ 873.7
20 year PW	2360.6	2546.2	2836.3
TOTAL	$3234.3	$3419.9	$3710.0
LONG TERM (2040) PW	$5851	$6212	$6807

*In Peak Month (December)

NOTE: Sensitivity analysis performed using 0% escalation, 3% interest rate and the midload forecast.

WATANA/
TABLE 22 SENSITIVITY ANALYSIS - TUNNEL CAPITAL COSTS

PARAMETER / JOB I.D.#	TUNNEL COST HALVED - MEDIUM LOAD W/T 1.5 L615	TUNNEL COST HALVED - LOW LOAD W/T 1.5 L613
1990 MW	1079 MW	1079 MW
1990-2010 THERMAL ADDS:		
Coal (MW)	200	-
NGGT (MW)	450	375
Diesels (MW)	30	20
TOTAL	680 MW	395 MW
RETIREMENTS (MW)	(734)	(734)
HYDRO ADDS: MONTH/YEAR NAME MW	6/93 W400 1/96 W400 1/00 T	6/93 W400 1/02 T
TOTAL FIRM* (2010)		
$\$ \times 10^6$ (80$)		
10 Year PW	$ 873.7	$ 744.1
20 Year PW	2474.2	1955.8
TOTAL	$3347.9	$2699.9
LONG TERM (2040) PW	$6232	$4726

*In Peak Month (December)