april 1982

the susitna hydro studies

This is the fourth of several newsletters published by the Alaska Power Authority for citizens of the railbelt. The purpose is to present objective information on the progress of the Susitna hydroelectric feasibility studies so that readers may make their own conclusions based on accurate information.

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IN THIS ISSUE:

results of the Susitna Hydroelectric Feasibility Study

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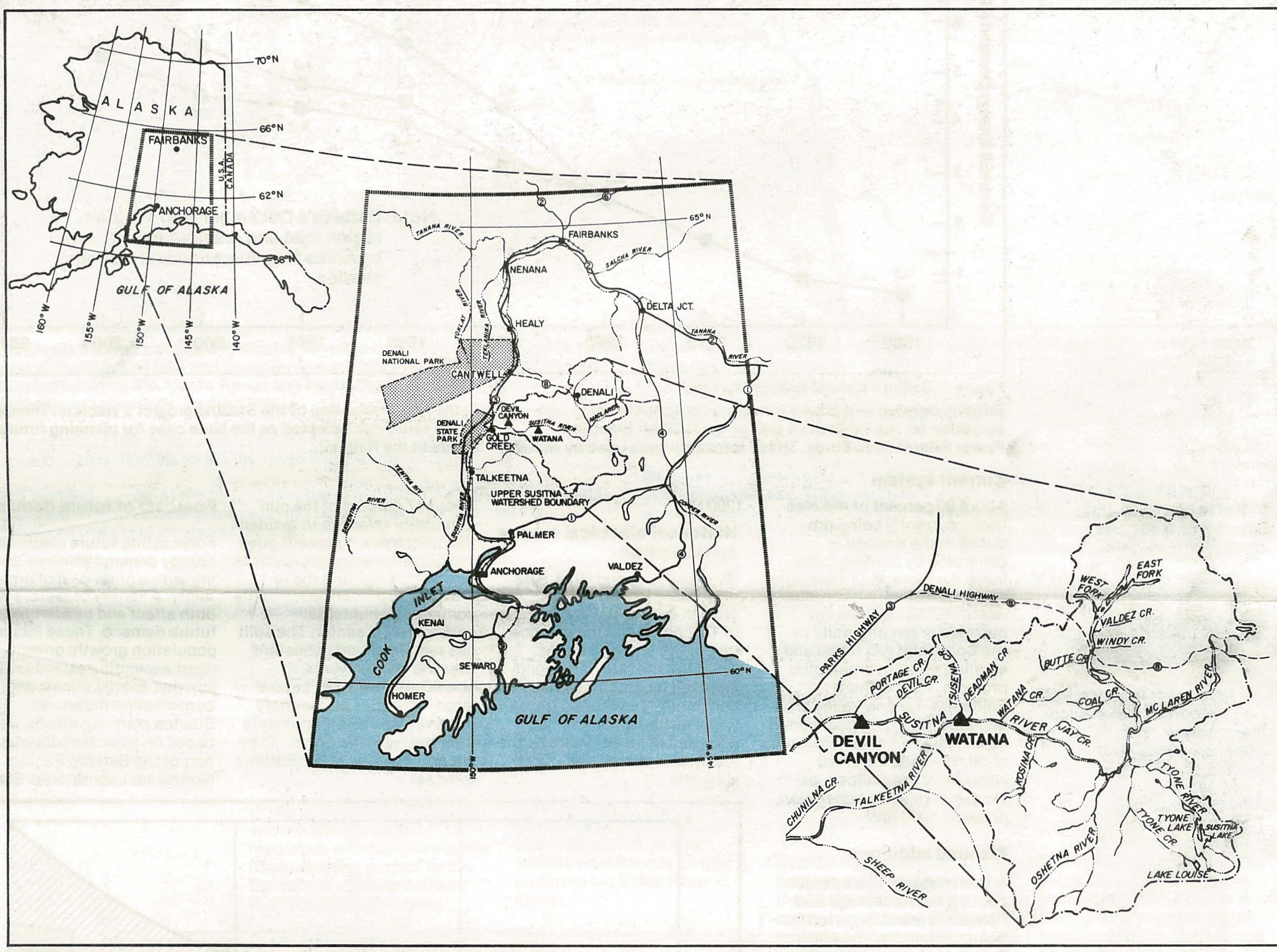


THE SUSITNA FEASIBILITY STUDY

Predicts long-term benefits, but not without risk

Introduction

After 2 years of study, Acres American, a Buffalo, New York consulting firm, has completed the Susitna Hydroelectric Project Feasibility Study. The study commissioned by the Alaska Power Authority in December 1979 has involved a detailed evaluation to determine technical and economic feasibility, and the environmental impacts of the optimal hydroelectric development for the upper Susitna basin.

The draft Susitna Hydroelectric Project Feasibility Report is a seven-volume report that details a proposed two-dam project at the Devil Canyon and Watana sites on the upper Susitna River and discusses the environmental and economic consequences of the project.

A separate and independent study of electrical energy generation alternatives for the Railbelt has been prepared by Battelle Pacific Northwest Laboratories, under terms of an agreement with the Office of the Governor. Acres used electric power demand and load forecasts that were developed by Battelle in the course of the alternatives study.

Study conclusions

The essential conclusions of the feasibility study are that the Susitna project is technically feasible and economically viable. Acres also reported that:

- The safety of the population in the vicinity of the project will not be impaired.
- The unavoidable impacts which this large project will cause on the environment will be substantial but not unduly severe and can be adequately mitigated.
- With State assistance, financing of the project is feasible at acceptable risk to Railbelt consumers.

The remainder of this newsletter will summarize the findings of Acres' feasibility study.

Source: Susitna Hydroelectric Project Draft Summary Report, March 1982, prepared by Acres American, Inc. for the Alaska Power Authority.

The energy needs of the Railbelt

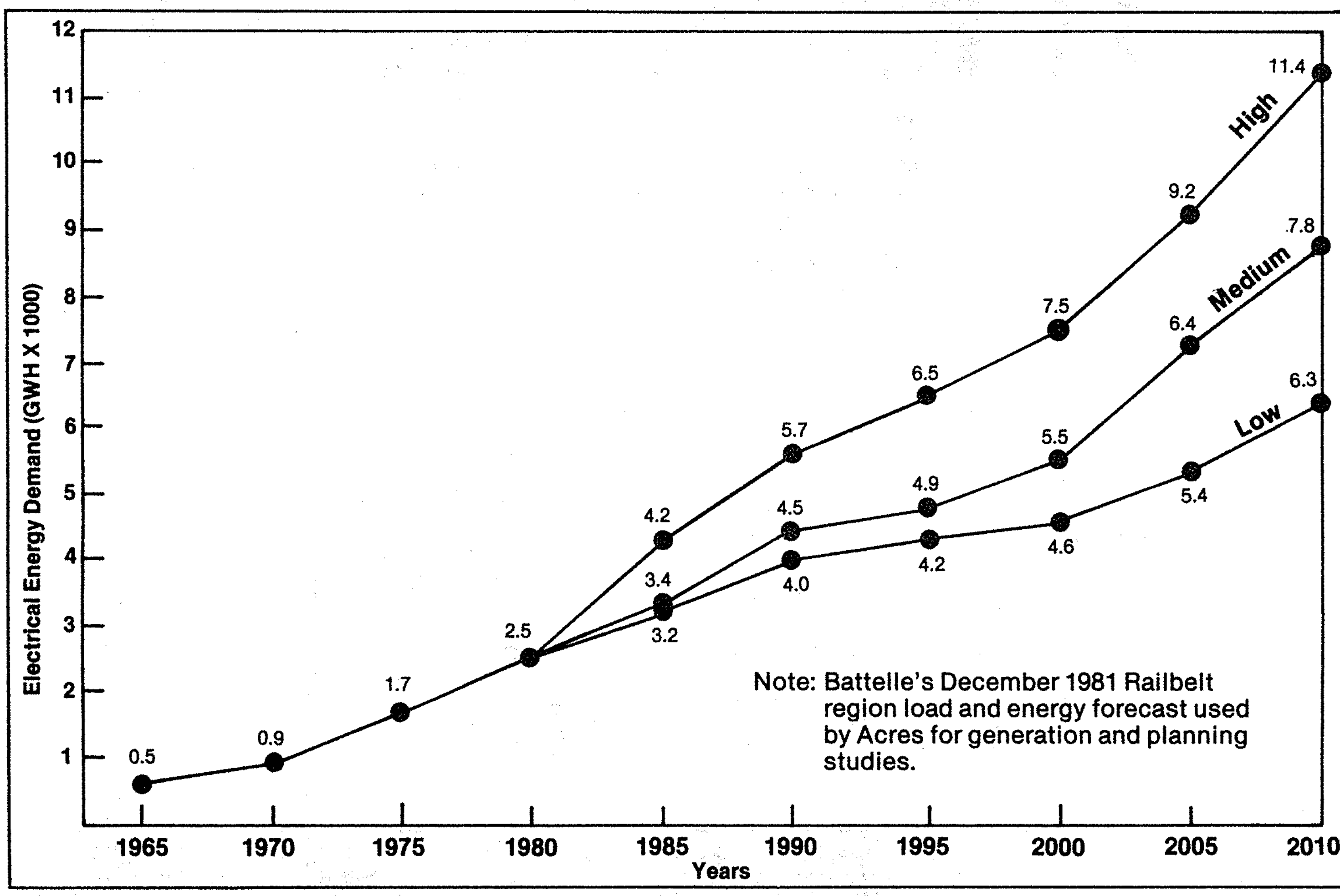


Figure 1: Railbelt Annual Energy Demand

Battelle developed demand forecasts for annual energy consumption for the Railbelt as part of the Railbelt Electrical Power Alternatives Study. These forecasts were used by Acres in the final evaluation of the Susitna project's viability. The mid-range value was selected as the base case for planning future needs in the Railbelt.

Current system

About 90 percent of the electricity currently being produced in the Railbelt is generated by burning fossil fuels. Anchorage and the other southern communities enjoy relatively low-cost energy because of the proximity of the Cook Inlet gas fields and existing small hydroelectric projects. The northern Fairbanks-Tanana Valley area depends mainly on coal mined near Healy and small amounts of oil. The total installed capacity of the Railbelt, exclusive of military generation, is nearly 1000 MW.

Planned additions

A transmission line interconnecting the Anchorage and Fairbanks areas is currently being planned by the Alaska Power Authority. The Intertie would permit the transfer of up to 70 MW of power between the load centers providing the opportunity for economic interchange of energy and sharing of reserve capacity. If the Susitna or other regional-scale project is built, the Intertie would be integrated into that larger, regional system. The Intertie is, however, economically feasible with or without a regional scale project.

Five new generating units are currently planned in the Railbelt. Two hydroelectric plants will provide about 97 MW with perhaps another 45 MW of spinning reserve. The larger of these plants is planned at Bradley Lake, east of Homer, with a capacity of either 90 MW or 135 MW. The Grant Lake project, also on the Kenai Peninsula, would provide an additional 7 MW.

One gas-fired combined-cycle unit and two gas turbines will also be constructed adding 160 MW. When the additions and scheduled retirements are accounted for, the total system capacity in the early 1990's is expected to be about 1200 MW.

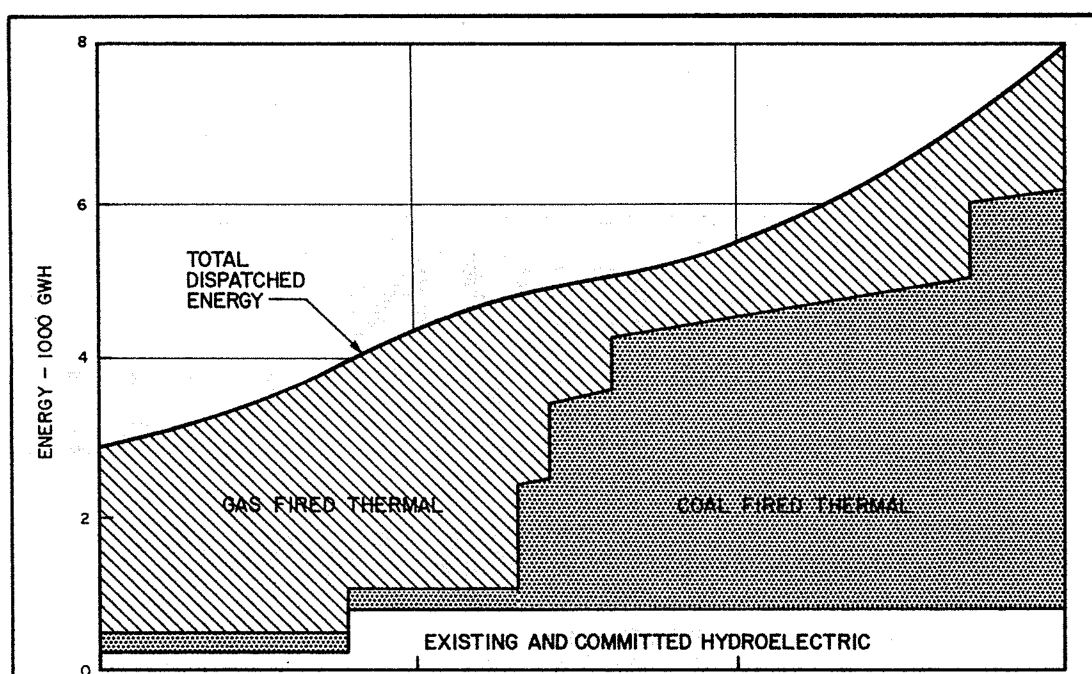
Historical electrical energy consumption

Between 1940 and 1978, electricity sales in the Railbelt grew at an average annual rate of 15.2 per cent, almost twice that of the lower 48 states. Although the rate of demand increase for electricity has consistently exceeded the national average, the rate has lessened in recent years as the Alaskan economy has matured.

About 47 percent of the current utility sales are to residential customers, 1 percent goes for miscellaneous use (such as street lighting), and the remaining 52 percent goes to the commercial-industrial-governmental sector. The split has remained fairly constant over the last ten years. It should be noted that several large industries and military bases in the Railbelt generate their own electric power. They are not included in the Battelle forecast.

Forecast of future demand

Forecasting future electrical energy demand involves dealing with a great deal of uncertainty. A variety of factors will both affect and be affected by future demand. These include: population growth; government expenditures; industrial activity; energy prices; and conservation measures. Susitna planning efforts were based on forecasts done as part of the Battelle Pacific Northwest Laboratories Elec-



VALUES OF SELECTED PARAMETERS

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

Figure 2: Thermal plan (Base Case) installation sequence

This figure illustrates the installation sequence developed by Acres for the non-Susitna thermal plan. It is this plan that provides a base case for comparing alternative Susitna developments and evaluating net benefits.

tric Power Alternatives Study. This work was a combined effort of the University of Alaska's Institute for Social and Economic Research and Battelle. Figure 1 shows Battelle's forecasts that were used in the final evaluation of the Susitna project.

Battelle developed low, moderate, and high forecasts as well as several special forecasts. A mid-range (moderate) forecast was selected as the base case, or the one Battelle believed was most likely to occur.

Between 1981 and 2010, the mid-range forecast suggests that electrical demand will grow at an annual rate of about 3.5 percent. The low range forecast results in an annual growth in demand of 2.8 percent, and the high range is 4.6 percent.

The high range forecast assumes several industrial developments such as the development of Beluga coal, U.S. Borax mining, a petrochemical plant, and a Valdez refinery as well as higher levels of spending by State government. The low and mid-range forecasts do not include these. None of the three forecasts included the development of an aluminum smelter, although a special industrial case did assume such a development. All forecasts include conservation of electricity that is attributed to the anticipated consumer reaction to rising energy costs.

The need for additional capacity

The currently scheduled additions to the Railbelt generating system are sufficient under the mid-range forecast to meet the increased demand and to replace units which must be retired until 1993. Between 1993 and 2010, about 1400 MW of capacity must be added.

If the current trend of using thermal generation continues, a shift to increased use of coal is likely to occur. The reasons for this are that Cook Inlet gas reserves may not be sufficient to meet increased demand and, regardless of availability, new gas supplies will become expensive as existing supply contracts expire between now and 1995. The availability of North Slope gas at Fairbanks remains uncertain during the study period. Even if a gas pipeline is built, Battelle projects the price to be higher than that for Cook Inlet gas.

Although it was not the purpose of the Susitna Feasibility Study to define the preferred alternatives to developing Susitna, Acres developed what they considered to be a reasonable "without Susitna" plan as a basis for determining the nature, phasing, and economical viability of the optimum Susitna project.

The all thermal plan

Acres American used a computerized generation planning model, Optimized Generation Planning (OGP), to develop a least-cost non-Susitna thermal alternative. This plan, shown on Figure 2, is based on coal generation and is similar to Plan 3 developed by Battelle in the independent Electric Power Alternatives Study.

The least-cost, non-Susitna thermal plan includes the addition of two 200-MW coal-fired steam plants at Beluga in 1993-4. Following the mid-range forecast, another 200-MW coal-fired plant would be constructed near Nenana in 1996. By 2007, another 200-MW coal-fired plant would be added at Beluga. In addition, several gas turbines would have to be installed to maintain peaking capacity, to satisfy reserve requirements, and to replace units that must be retired. Existing and planned hydroelectric units are included, but no additional hydro is developed.

An important assumption included in the calculation of the cost of the thermal plan is that the Beluga coal fields are developed on a commercial scale within the next decade. Even if electric generation in the Railbelt uses coal as the main fuel, a substantial export market will have to develop before development of the Beluga fields is economically feasible. The cost of the thermal plan would increase if the Healy fields were the only available coal source, or if the only market for Beluga coal was for electrical energy generation in Alaska.

Of the hydroelectric options available in the Railbelt other than Susitna, the most economically promising appears to be the Chakachamna Lake project, located 80 miles west of Anchorage. The Chakachamna project would provide about 25 percent of the energy that the Susitna project could provide. Chakachamna was not included in the base case plan because knowledge about the project is not sufficient to estimate capital costs with a precision comparable to the other alternatives. Also preliminary environmental studies suggest relatively large impacts, especially on fisheries, with difficulties in mitigation. Nevertheless, a sensitivity analysis was done to determine the extent that developing Chakachamna would likely affect the cost of the thermal plan. This is presented later, as well as more general information concerning the proposed Chakachamna development.

Proposed Susitna development

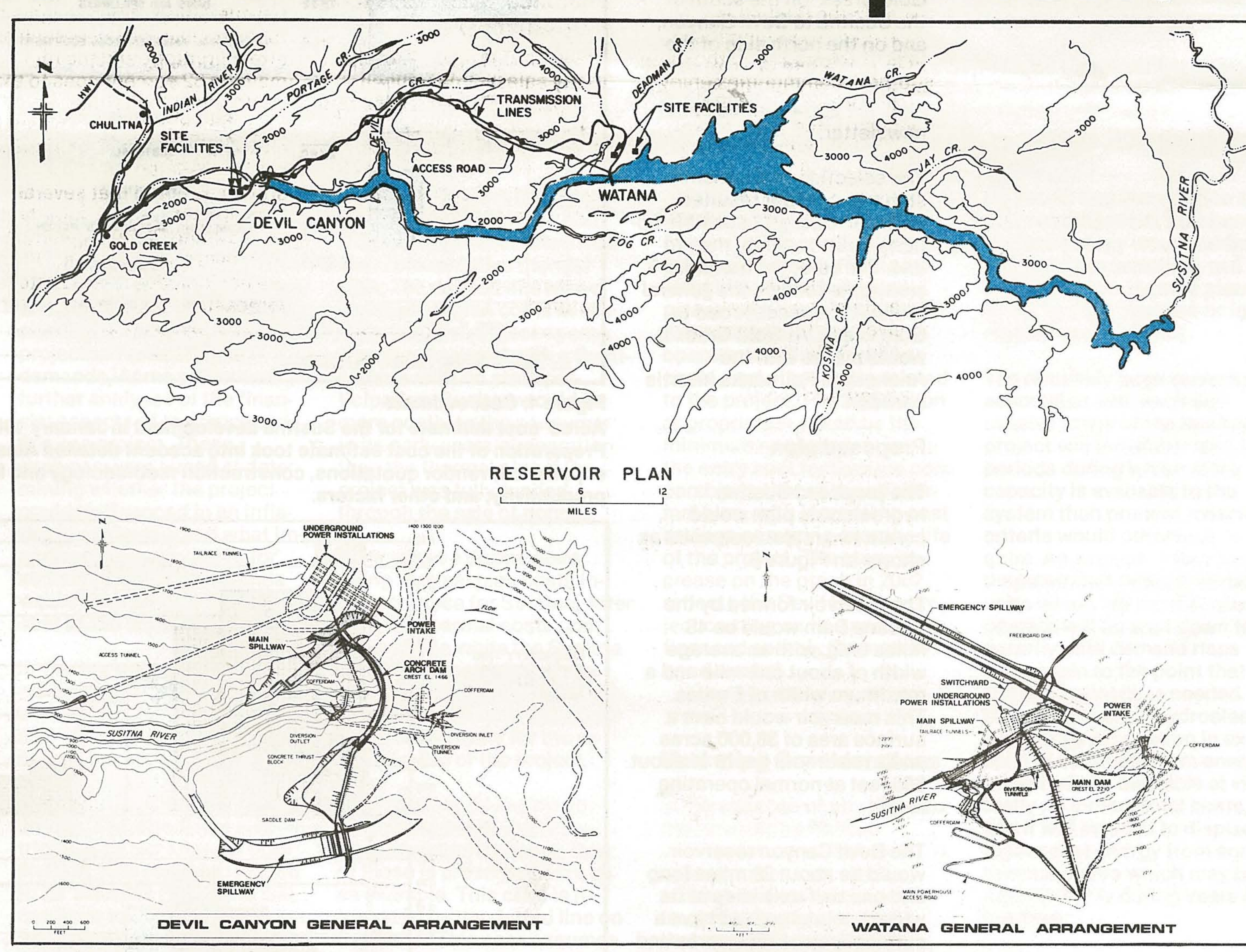


Figure 3: Proposed development plan

The Watana and Devil Canyon dams would create two reservoirs, 48 and 26 miles long respectively. During construction temporary full-service construction camps would be located at each dam site. A permanent town would be developed near Watana for the operating and maintenance staff. An access road would be constructed from the Parks Highway to Gold Creek, on the south side of the Susitna to Devil Canyon, and on the north side of the Susitna to Watana. In addition, a 6000 foot air strip would be constructed near the Watana site.

Plan formulation

The steep narrow canyons in the upper Susitna basin offer a number of possible dam sites. In addition, each individual site offers a range of possible development alternatives. Early in the study, 12 sites were identified and analyzed on the Susitna River above Gold Creek.

After detailed technical, economic, and environmental screening, three developments were selected for detailed evaluation: (1) the Watana and Devil Canyon sites; (2) High Devil Canyon and Vee sites; and (3) a combination of a dam at Watana, a low regulation dam downstream, and a tunnel from the low dam to a downstream portal near Devil Canyon.

A Watana-Devil Canyon development was determined to be superior on all criteria to the High Devil Canyon-Vee plan. The Devil Canyon dam was favored over the low dam-tunnel option on economic and energy production criteria, although the tunnel plan appeared to have environmental advantages. Development of dams at the Watana and Devil Canyon sites was selected as the preferred plan. The tunnel option and the decision not to pursue it were discussed in

Continued on p. 4

Proposed Susitna Development

Continued from p. 3

the September 1981 newsletter.

Access and transmission planning

In addition to selecting sites for the dams, alternative plans were formulated in order to select access and transmission line routes.

Three main access corridors were selected after initial screening. They were: 1) from the Parks Highway to Gold Creek, along the south side of the Susitna River to Devil Canyon, then north of the river to Watana; 2) same as 1) except south of the Susitna after Devil Canyon; and 3) south from the Denali Highway to Watana, eventually connecting to Devil Canyon.

Eleven different plans involving combinations of road and railroad were produced for the three corridors. Several objectives were selected to evaluate the preferred plan. These objectives were: 1) allowing construction to proceed on time; 2) minimizing construction and logistics cost; 3) facilitating operation and maintenance; 4) minimizing adverse biological impacts; 5) accommodating preferences of local communities and Native landowners; and 6) accounting for the concerns of State and Federal resource agencies.

Although no access plan was consistently best in meeting all objectives, Acres recommended an all road alternative from the Parks Highway to Gold Creek, on the south of the Susitna to Devil Canyon, and on the north side of the river to Watana. A more detailed discussion of access planning will appear in the next newsletter.

The selection of a transmission line corridor resulted from narrowing 22 possible options down to three, then to one. The selected transmission route follows the general route of the access road to Gold Creek. At Gold Creek it would merge with the Anchorage-Fairbanks Intertie corridor.

Proposed plan

The proposed Susitna hydroelectric plan would create two major reservoirs as shown on Figure 3.

The reservoir formed by the Watana Dam would be 48 miles long, with an average width of about one mile and a maximum width of 5 miles. This reservoir would have a surface area of 38,000 acres and a maximum depth of about 680 feet at normal operating level.

The Devil Canyon reservoir would be about 26 miles long and one half mile wide at its widest point. It would have a surface area of 7800 acres and a maximum depth of about 550 feet at normal operating level.

Temporary full-service construction camps would be developed near each dam site. These facilities would be removed after the project is complete, but a permanent town near Watana would remain to accommodate the needs of the approximately 130 operating and maintenance staff and their families. Recreational, educational, religious, medical, commercial, sanitation, and water supply facilities would be included in both the construction camps and the town. The access road provided for construction would provide access to and from the town. In addition, a 6000 foot airstrip would be constructed.

Watana

The main dam at Watana would be an earthfill structure with a maximum height of 885 feet, 4100 feet long at the crest (top), and have a total volume of 62,000,000 cubic yards of fill material. To construct the dam, upstream and downstream cofferdams would be built to protect the construction area from floods. The river would be diverted through two, 38-foot-diameter, concrete lined diversion tunnels in the north bank of the river.

The dam foundation would be excavated to solid rock through its cross-section and allowances would be made for extensive consolidation and curtain grouting. Grouting would be done from underground tunnels that would be used later for drilling drainage pressure relief holes. The main core of the dam would be a trapezoidal section separated from the outer granular fill section. The entire upstream face and the downstream toe would be rip-rapped.

The power intake would be on the north abutment. A multi-level, concrete intake structure capable of operating over the full 140-foot draw-down range would be included to maintain, as much as possible, downstream water quality. From the intake, water would enter six concrete lined penstocks leading to steel-lined sections terminating in an underground powerhouse. The powerhouse would have six Francis turbines, each producing 250,000 horsepower.

From the turbines, water would flow into a surge chamber and then into the river through two concrete-lined 30-foot diameter tailrace tunnels. Oil filled cables would extend from a transformer gallery upstream of the powerhouse to a surface switchyard.

Outlet facilities would be capable of discharging floods with frequencies of 50 years or less through six fixed-cone valves which minimize nitrogen super-saturation. Two other spillways would be provided. The main chute spillway on the right abutment can handle up to one in 10,000 year floods; the emergency spillway, also on the right bank, is capable of handling the maximum probable flood without overtopping the dam.

Devil Canyon

The Devil Canyon dam would be a double-curved arch structure 645 feet high and about 1500 feet long at the crest. The crest of the dam would be a uniform 20 feet and the maximum width of the base would be 90 feet. The center section of the dam would be a concrete pad built on bedrock. A rock-fill saddle dam on the south bank would be constructed to approximately 245 feet above the foundation level.

Cofferdams and a 30 foot diversion tunnel would provide protection during construction against floods with a 25 year or less frequency of occurrence. Less flood protection would be provided at Devil Canyon than Watana because of the shorter construction period, the river regulation afforded by Watana, and the fact that Devil Canyon would be less susceptible to damage than Watana.

A power intake capable of accommodating maximum drawdown of 55 feet would provide water to an underground powerhouse through four concrete-lined penstocks, each 20 feet in diameter. The

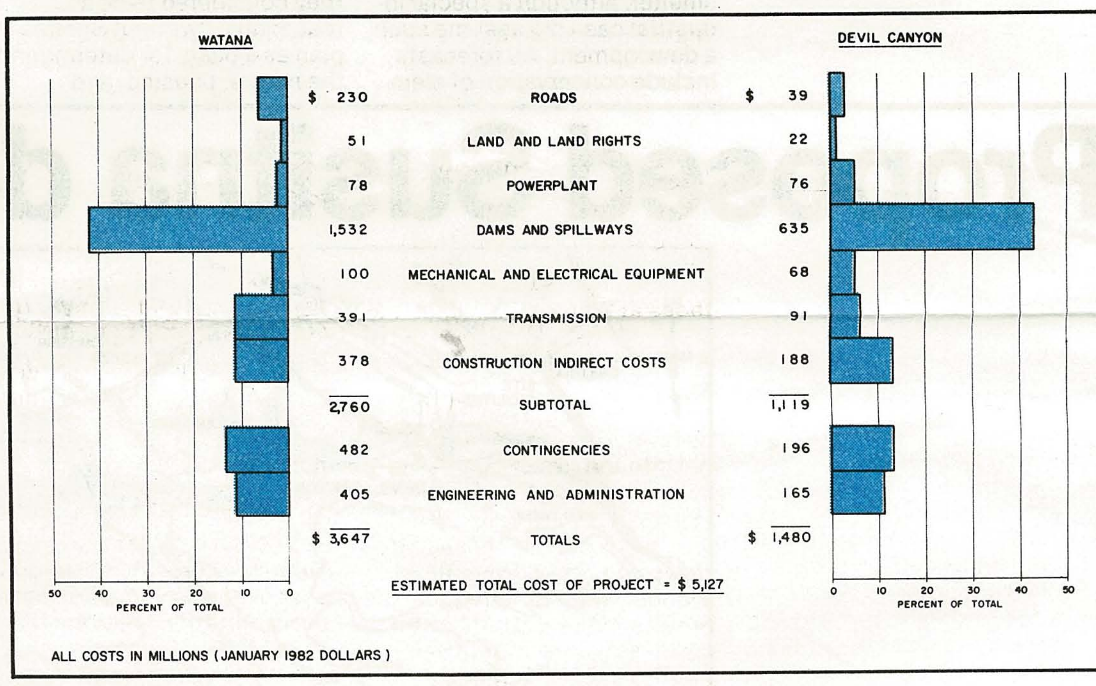


Figure 4: Cost estimate

Acres' cost estimate for the Susitna development in January 1982 dollars is about $5.1 billion. Preparation of the cost estimate took into account detailed Alaska-specific data and historical experience, vendor quotations, construction methodology and feasibility, seasonal influences on productivity, and other factors.

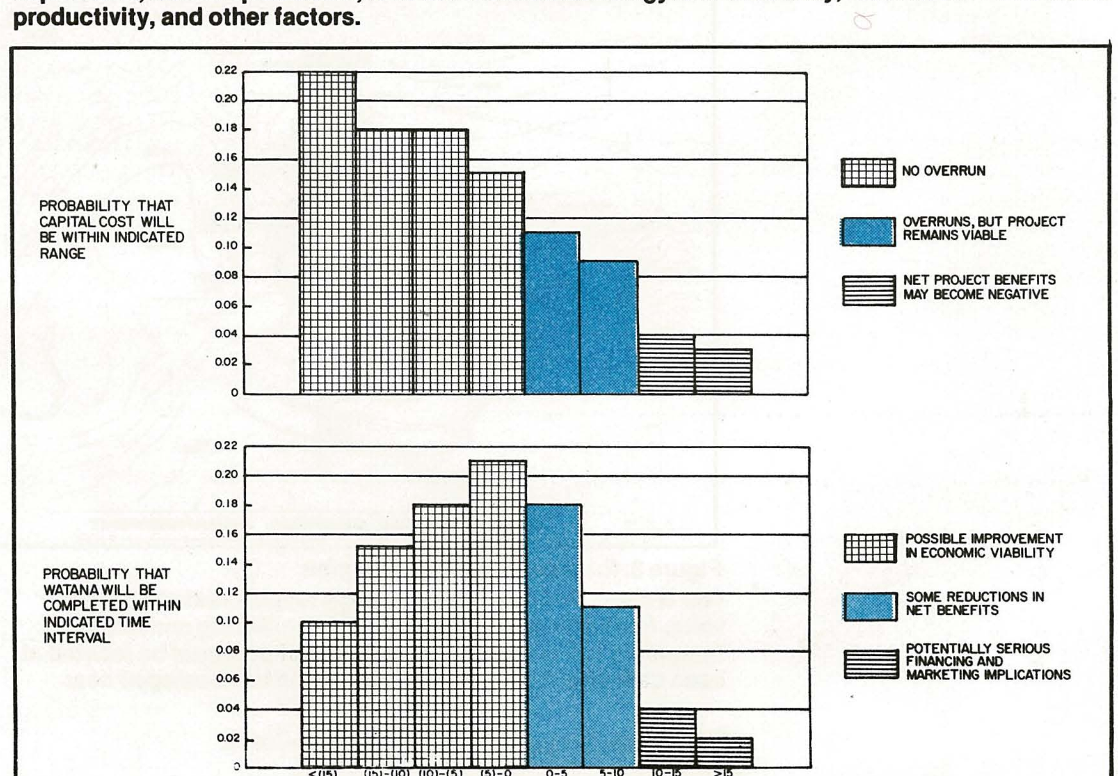


Figure 5: Cost and Schedule Risk Analysis

The cost risk chart shows that the probability of the Watana project being completed at a total cost between 90 percent and 100 percent of the cost estimate is 0.15. Acres reports a probability of 0.73 that the actual cost (in 1982 dollars) will not exceed the estimate. On the other hand, there is a 7 percent chance the proposed Susitna project would have overruns so great that the thermal option would prove to be more cost effective. The schedule risk chart indicates that there is about a 6 percent chance that delays other than those caused by regulatory matters could have serious financing and marketing implications.

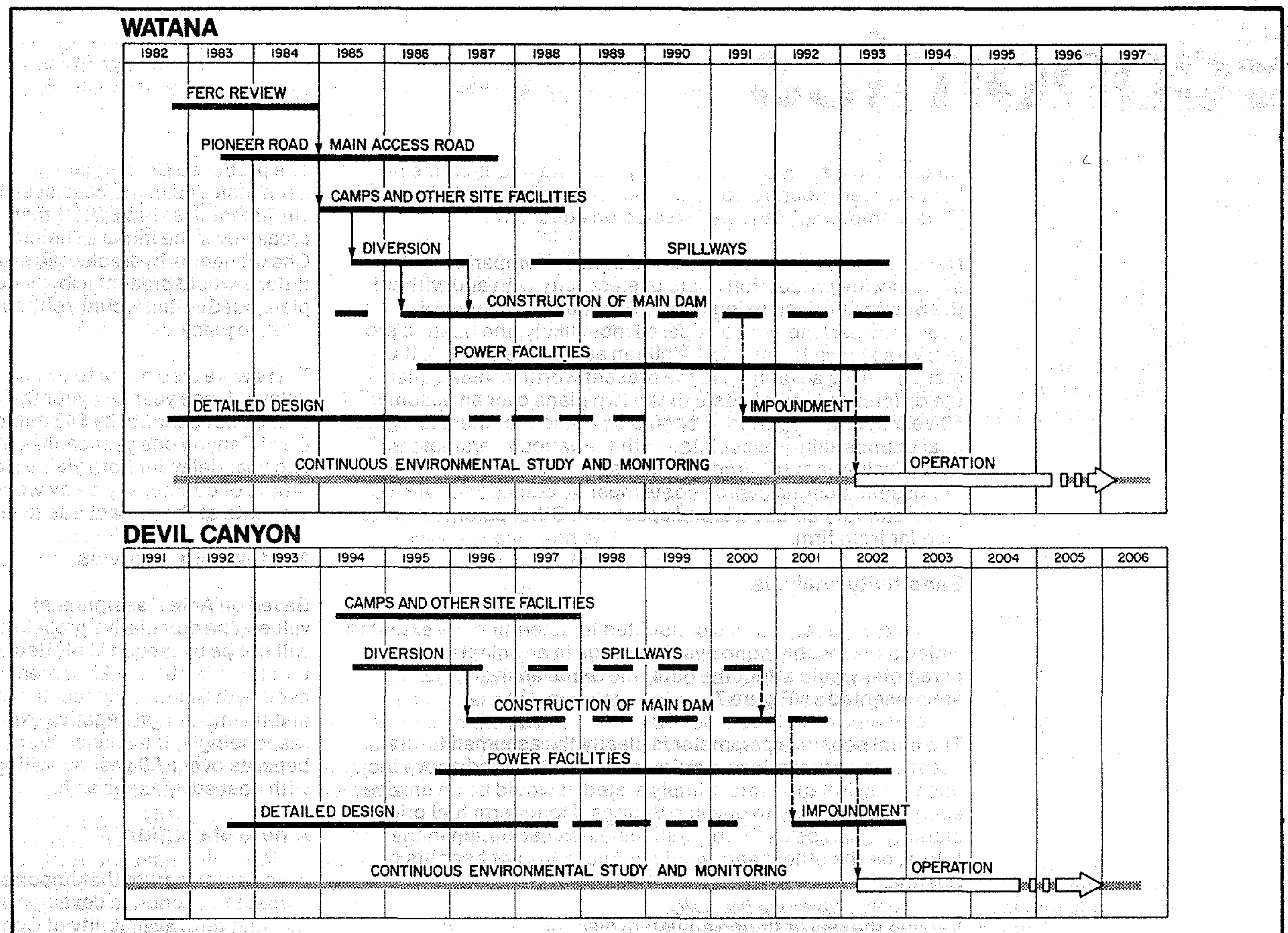


Figure 6: Project schedule

Because generation planning studies indicated that capacity must be added to the Railbelt system in the early 1990's, construction planning for the proposed Susitna project has been based on meeting a 1993 power-on-line schedule. This figure provides a broad schedule of activities that must take place if the Susitna project is to meet the 1993 power-on-line date.

powerhouse would house four 225,000 hp Francis turbines. The transformer gallery, oil-filled cables, and surface switchyard would be similar to those at Watana.

After passing through the turbines, water would flow into a surge chamber, then through a 38 foot-diameter tailrace tunnel into the river. Seven fixed-coned valves located in the lower part of the main dam would be capable of passing flows up to the 50-year flood. Floods with return frequencies between 50 and 10,000 years would be handled by a main, chute spillway on the right bank. An emergency spillway on the left bank would pass the probable maximum flood.

Cost

The capital cost estimate for the Susitna project in January 1982 dollars, exclusive of allowances for funds used during construction, is reported by Acres at approximately $5.1 billion. Figure 4 summarizes the major accounts for the Watana and Devil Canyon projects. Allowances of about $150 million have been included for mitigation measures that are integral to project design, or appropriate for aesthetic and socioeconomic concerns. These include such items as multi-level intake structures, fixed-cone outlet valves, restoration of disturbed areas, and self-contained camp facilities.

Acres conducted a risk analysis to determine the confidence level of the estimate as well as to define the probability of exposure to serious cost overruns. Figure 5 shows probability distributions for selected intervals of possible cost and schedule variations.

Construction schedule

Construction planning for the proposed project is based on meeting a 1993 power-on-line date. This would provide the capacity that generation planning studies indicated must be added to the Railbelt system in the early 1990's. Figure 6 shows a broad schedule of events that must take place if the Susitna project is to meet the completion date.

If the State decides to proceed with the project, a Federal Energy Regulatory Commission (FERC) license application would be submitted on September 30, 1982. The licensing process is expected to take up to 27 months. This is necessary to accommodate comment by resource agencies, organizations, and concerned individuals as well as to allow time for the extensive technical and environmental review conducted by FERC in preparation of an environmental impact statement.

Several activities would proceed during the licensing process. Beginning in mid-1982 the detailed design phase would begin, and field investigations of fisheries, wildlife, and foundation conditions would continue.

When and if the FERC license is awarded, construction activities would begin on the Watana project. All diversion facilities, including cofferdams, would be completed by spring of 1987. Major construction activities for the various project components would proceed simultaneously. Reservoir filling would begin after break-up in 1991 or as soon as the main dam is high enough to safely permit it.

Devil Canyon's schedule is less critical since power is not needed according to the mid-range forecast until 2002. Depending on demand, the construction of Devil Canyon can be accelerated or delayed.

Employment opportunities would be significant during the construction of the Susitna project. A gradual increase in the work force would lead to an average of about 1450 persons between 1985 and 2000. The peak work force would occur in 1990 with about 3500 workers.

If you want to get future newsletters

This public information document on the Susitna hydropower project was developed by the Alaska Power Authority Public Participation Office, Nancy Blunck, Director. Comments on the substance of this newsletter and ideas for future publications should be forwarded to the Public Participation Office by way of the following coupon.

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THANK YOU FOR YOUR INTEREST

Economics

All economic analyses to identify plans and to determine net benefits were conducted on a common, nonsubsidized basis. Thus, competing plans were tested on equal terms.

Net economic benefits were calculated by comparing the system-wide production costs of electricity with and without the Susitna project, using the OGP model. For the set of economic parameters considered most likely, the Susitna project was shown to have a $1.2 billion advantage over the thermal plan. This advantage is the present worth in 1982 dollars of the difference in total costs of the two plans over an assumed 50-year operating period. It should be noted that there is a great deal of uncertainty associated with the various parameters whose values contributed to this result. For example, a range of possible Susitna capital costs must be considered, and demand can vary across a broad spectrum. Other parameters are also far from firm.

Sensitivity analysis

A sensitivity analysis was conducted to determine the extent to which a reasonably conceivable change in any single parameter would affect the outcome of the analysis. Results are presented on Figure 7.

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

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

The proposed Chakachamna hydroelectric project had not been included in the base case for reasons noted earlier. If environmental issues can be resolved there and if costs do not increase over the initial estimates, a combination of the Chakachamna hydroelectric project and thermal generation additions would present a lower cost alternative than the thermal plan, but Susitna would continue to be favored in terms of relative plan costs.

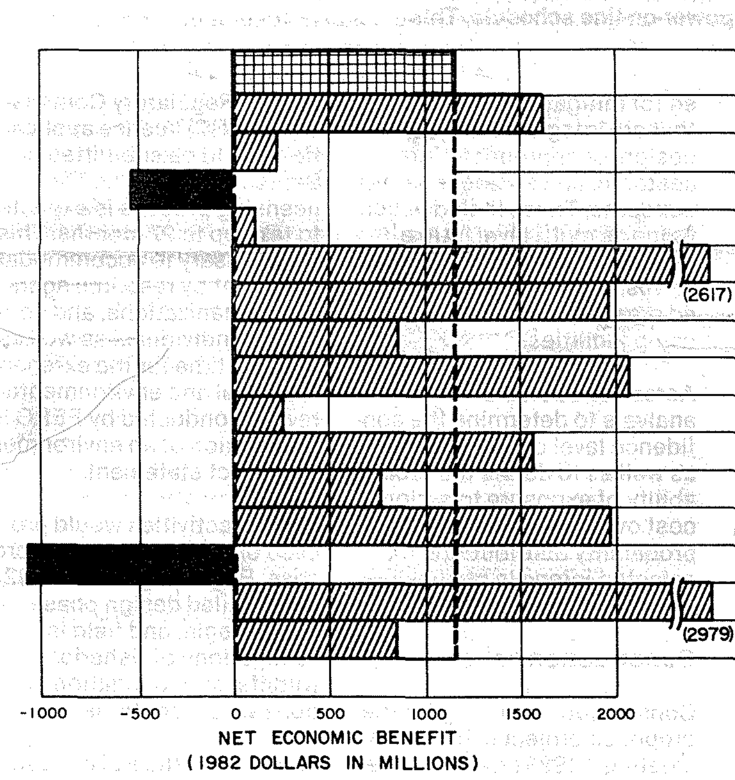
Tests were also made to evaluate the economic effects of delays. A one year delay for the Watana project alone would reduce net benefits by $43 million. Delaying both Watana and Devil Canyon one year causes a reduction of $103 million. A two year delay for both yields a decrease of $168 million. In addition, of course, any delay would increase the actual dollar amounts of the project due to inflation.

Multi-variate analysis

Based on Acres' assignment of probabilities to the parameter values, the cumulative probability that a particular net benefit will not be exceeded is plotted on Figure 8. This figure shows that there is about a 23 percent chance that a decision to proceed with Susitna will result in negative or zero net benefits, and the maximum negative exposure is about $2.5 billion. Correspondingly, the chance that Susitna will produce positive net benefits over a 50-year operating period is about 77 percent, with cost advantages as high as $5.5 billion.

A note of caution

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



PARAMETER TESTED

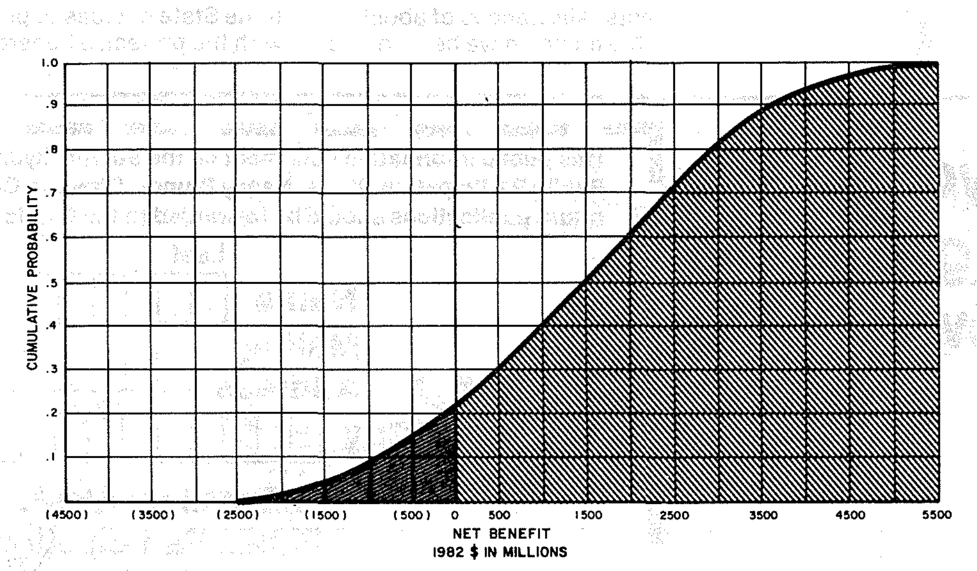
BASE CASE	BASE CASE VALUE
HIGH LOAD FORECAST (11,400 GWH IN 2010)	7,800 GWH IN 2010
LOW LOAD FORECAST (6,300 GWH IN 2010)	7,800 GWH IN 2010
5 % REAL DISCOUNT RATE	3 %
4 % REAL DISCOUNT RATE	3 %
2 % REAL DISCOUNT RATE	3 %
HIGH CAPITAL COST FOR ALTERNATIVE (20 % ABOVE ESTIMATE)	BATTELLE ESTIMATE
LOW CAPITAL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

Figure 7: Sensitivity analysis

Acres conducted a "sensitivity analysis" to determine the extent that a reasonably conceivable change in a single economic parameter would have on the outcome of their economic analysis. Fuel escalation rates, especially for coal, are the most sensitive parameters. A high fuel price escalation rate increases the net benefits of Susitna, while a stable price of coal has the opposite effect.

Figure 8: Multi-variate sensitivity

Given the uncertainties involved in each of the parameters subjected to sensitivity tests, there is no reason to believe that only one parameter would vary from the assumed center-point values. To test the effect of multiple variations, a "decision tree" was constructed and the probability of occurrence was assigned to each of three possible values for the four most sensitive parameters. Long-term present worth costs were determined for each possible combination of load forecast, Susitna capital cost, alternative capital cost, and fuel cost escalation. The figure shows the probability that a particular level of net benefit will not be exceeded.



Environmental issues

Environmental issues in the context of the proposed Susitna development are addressed first in this section. Potential impacts associated with the non-Susitna plan are then summarized. The January 1982 newsletter also covered some of the environmental concerns associated with the proposed Susitna project.

Water quality and downstream flow

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

Sediment capture efficiencies for the proposed reservoirs are estimated at 70 to 100 percent. In 100 years, the estimated sediment deposition will represent about 5 percent of the gross reservoir volume at Watana and about 10 percent at Devil Canyon. No reduction in energy production as a result of sedimentation is anticipated during the project life. As a result of sediment entrapment, flows downstream of Devil Canyon will be considerably less turbid in late spring, summer, and early fall. Winter flows will be more turbid than under natural conditions. Other water quality changes will occur, but no significantly adverse impacts are anticipated.

Figure 9 provides a hydrograph which relates average flows under natural conditions with those which would normally be provided after the project is completed. Below the confluences with major tributaries of the Susitna River, differences between pre-and post-project flow conditions will be less pronounced, as the entire upper basin contributes less than 20 percent to the total average annual discharge of the Susitna River into Cook Inlet.

Fisheries

The Susitna River is a major contributor to Cook Inlet fisheries. More than half of the combined Cook Inlet total of chum, sockeye, coho, and pink salmon return to the Susitna to spawn. The main stream provides a migratory corridor, while most of the spawning habitat is located within tributaries, side channels, and sloughs. Resident fish species also abound in the basin. Presently, no salmon species migrate into or above the project area.

If the Susitna project is constructed, the principal fishery impacts would occur in the side channels and sloughs upstream of the confluence of the Talkeetna River and the Susitna main stream. In the absence of any mitigation efforts, the greatly altered post-project flow regime and warmer water temperatures in winter could result in a reduction of a portion of each of the five species of salmon that enter the Susitna system.

Based on the escapement data collected during the 1981 field season, estimates were made of the numbers of salmon that start up the Susitna River at the Susitna Station and those that pass Talkeetna to spawn in the upper river below Devil Canyon. The percentage of the total Susitna salmon that utilize the Devil Canyon to Talkeetna stretch of the river are shown in the following table.

Species of Salmon	Percentage of Total Susitna Run
Coho (silver)	8%
Chinook (king)	2%
Sockeye (red)	1%
Pink (humpy)[1]	3%
Chum (dog)	15%

[1])Data based on odd-year run of pinks; even-year runs are traditionally higher.

Assuming that the adverse impacts on salmon would occur mainly above Talkeetna, the percentage of the Susitna salmon run that would be lost if no mitigation is provided is shown above. These figures will be modified as data from the next summer's field studies become available. When improved with the new data, these figures can serve as a guide for mitigation planning.

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

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

Wildlife resources

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

The primary impact on moose populations would be the loss of habitat and the resultant loss of moose in areas inundated by the reservoirs. In addition some reduction in downstream winter browse may occur as altered flow regimes affect vegetative succession. Habitat management is the principal mitigation measure being explored to maintain the moose population. Controlled burning to stimulate browse growth and reclamation of areas of disturbance are typical examples of habitat management being considered.

Although not recently used, an important historical migration route for caribou would be intersected by reservoir impoundment. Mud flats and shoreline ice conditions could impede caribou migration despite their excellent swimming capability. Monitoring spring migration to locate calving areas and protection of calving grounds from human intrusion during the calving period are proposed. Clearing

Continued on p. 8

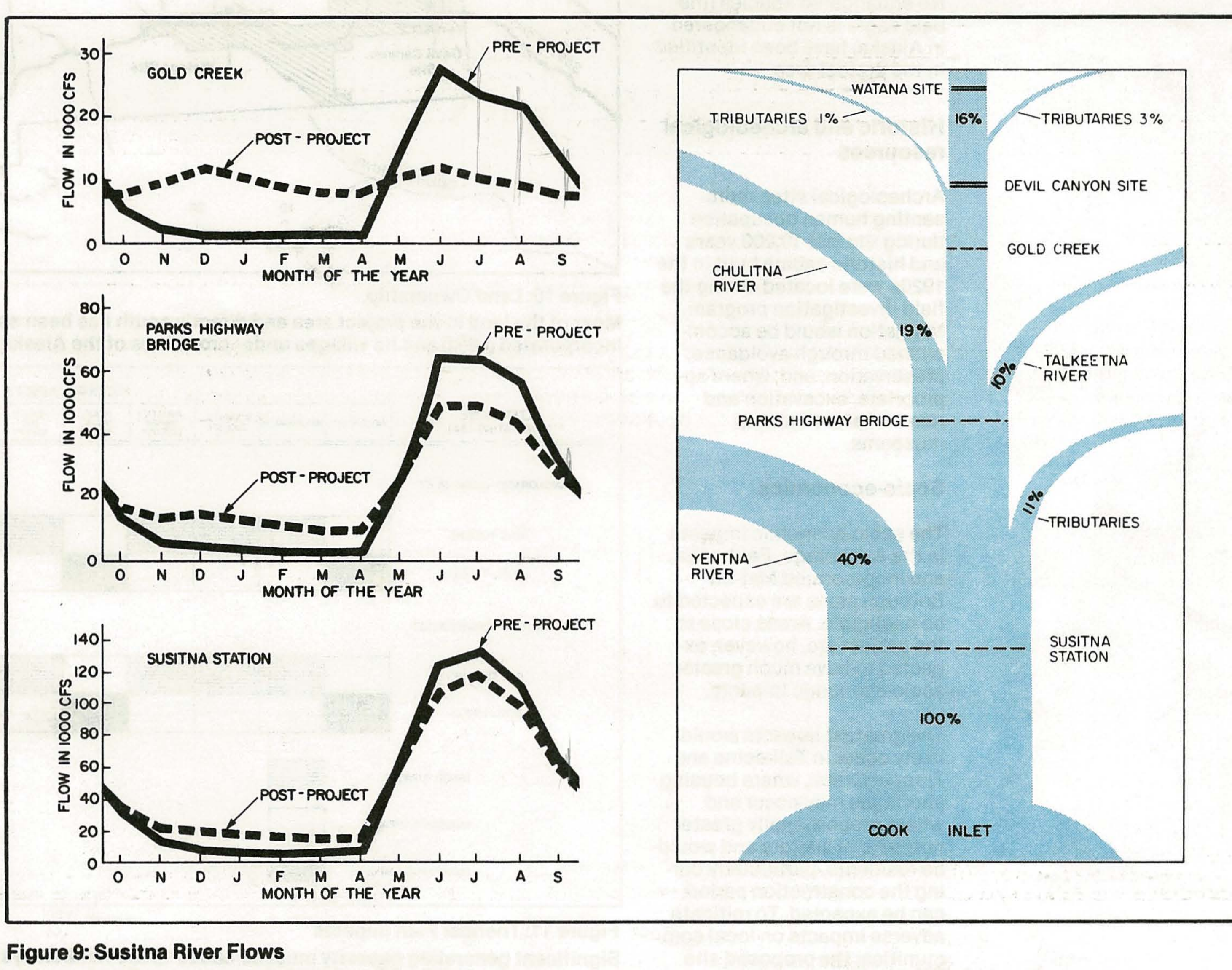


Figure 9: Susitna River Flows

The Susitna River above Talkeetna contributes less than 20% of the total discharge into Cook Inlet. The hydrographs above show a comparison of average flows at several downstream locations under natural conditions with flows that would normally be provided after completion of the project.

Environmental issues

Continued from p. 7

and removal of trees from the reservoirs is also proposed, to prevent mortalities which may be caused by floating debris.

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

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

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

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

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

Historic and archeological resources

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

Socio-economics

The socio-economic impacts in the Anchorage, Fairbanks, and incorporated Mat-Su Borough areas are expected to be negligible. Areas close to the project are, however, expected to have much greater socio-economic impacts.

The greatest impacts would likely occur in Talkeetna and Trapper Creek, where housing shortages may occur and where proportionally greater numbers of visitors and would-be residents, particularly during the construction period, can be expected. To mitigate adverse impacts on local communities, the proposed site facilities include construction camps and a permanent town site fully equipped with all amenities. The construction camps would reduce the need for travel to the local communities for shopping and services. As the project proceeds, coordination would be maintained with local communities to monitor changes in the communities and determine ways to mitigate impacts.

Generally speaking, the overall demand for services in the Railbelt (e.g. water supply, police, education, etc.) would increase by less than 5 percent, particularly if workers are drawn from within the Railbelt, as expected. Business activities would be stimulated because of the increase in project related spending and the spending patterns of the work force.

Significant employment opportunities would be generated in the Railbelt over the 15 year period of the project. About 85 percent of the work force would be drawn from the Anchorage, Fairbanks, and Mat-Su Borough areas. Another estimated 5 percent of the work force would come from other parts of the State of Alaska, with 10 percent of the workers coming from outside. Of those workers coming from out-of-state, many would settle in Anchorage or the Mat-Su Borough.

Land ownership and use

As shown on Figure 10, most land in the project area and directly south has been selected by Native corporations under provisions of the Alaska Native Claims Settlement Act. The U.S. Bureau of Land Management generally manages lands to the north.

Existing land use in the upper basin is typical of that of interior undeveloped Alaska, including hunting, fishing, trapping, mining, and recreation. Broad expanses of wilderness areas are present, access is restricted, and only a few man-made developments or structures are currently found. Early in the feasibility study period, a camp near the Watana dam site was erected on native land to support field investigation activities. In the event that the Susitna project does not proceed, this camp facility may revert to Native ownership, and some further developments by the Native land owners would probably occur.

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

Environmental impacts of the non-Susitna plan

Coal-fired steam generating plants, the principal component of the non-Susitna thermal plan, would be developed in open, well-ventilated sites as near as possible to available coal fields. Visual impacts would be significant since plumes from cooling towers and smokestacks would be seen for miles, particularly in winter months. Local air quality degradation would be inevitable. Relatively large land areas would be required to accommodate major plant components, stockpiles, and mining operations. Lesser, but nonetheless important, impacts in other categories as shown on Figure 11 would also occur.

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

Impacts from the construction of a hydroelectric plant at Lake Chakachamna would be generally of the types described for the Susitna project. Studies of a Chakachamna development have not reached the point where definitive estimates of potential fish losses can be made, but initial indications are that fisheries impacts may be substantial. The Chakachamna development is discussed in a separate article later in the newsletter.

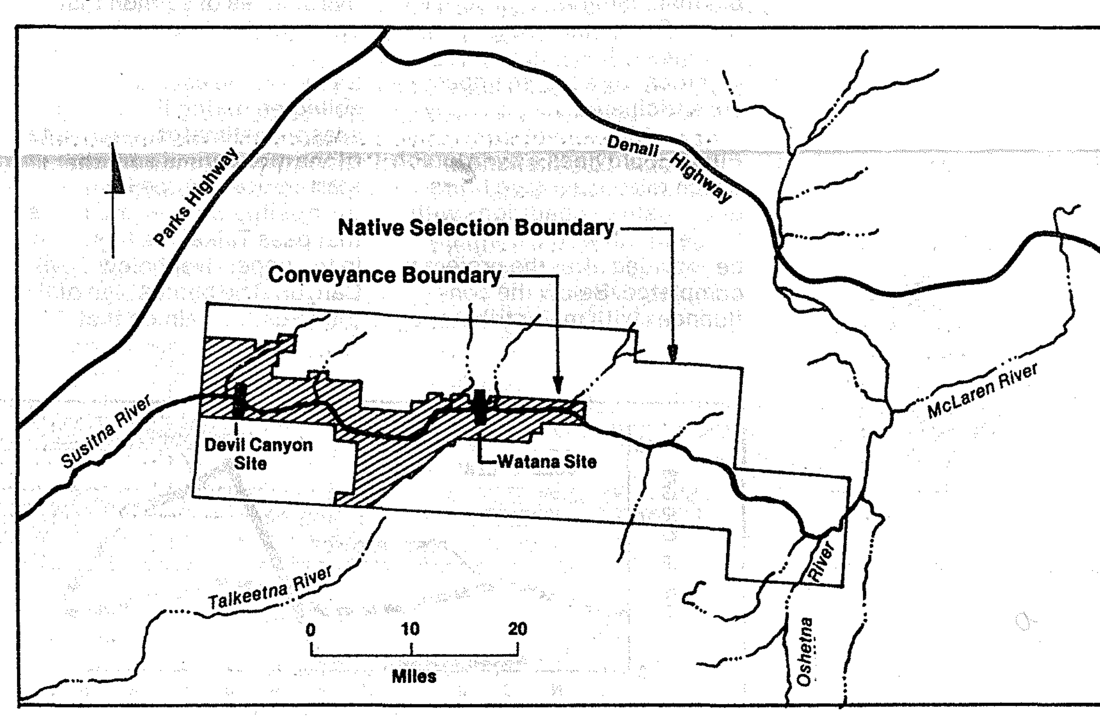


Figure 10: Land Ownership

Most of the land in the project area and directly south has been selected by Cook Inlet Region Incorporated (CIRI) and its villages under provisions of the Alaska Native Claims Settlement Act.

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

MINOR IMPACTS / MODERATE IMPACTS / SIGNIFICANT IMPACTS

Figure 11: Thermal Plan Impacts

Significant generating capacity must be added to the Railbelt system during the study period if the mid-range forecast is realized. If, instead of proceeding with Susitna, the thermal plan is developed, different types of environmental impacts can be expected. This figure summarizes impacts presented in the Battelle Railbelt Electric Power Alternatives Study for system additions that would likely be built if the Susitna development is not pursued.

Financing and marketing

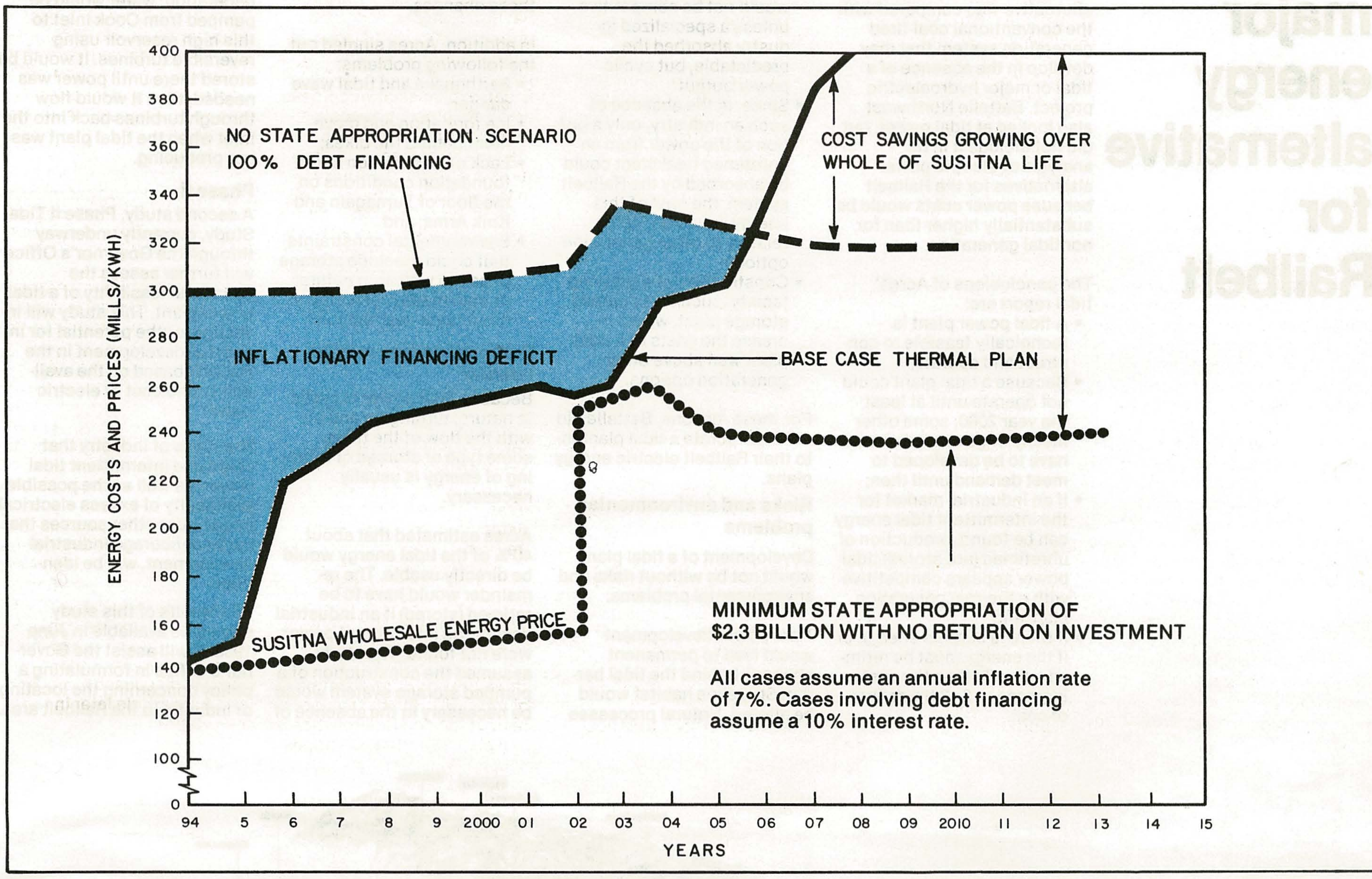


Figure 12: Comparison of Annual Electricity Prices

Acres also conducted analysis to determine whether the project could be financed in an inflationary economy and what effect various levels of state appropriation would have on the ultimate wholesale cost of power. Three representative cases are shown in this figure as well as the anticipated price trend for an all thermal plan, without any state contribution.

Having found that there is a significant probability that developing the hydroelectric potential of the Susitna basin would provide significant cost advantages when compared to alternative means of meeting projected Railbelt power demands, Acres performed further analyses of the financial aspects of the proposed Susitna project. These analyses were aimed at determining whether the project could be financed in an inflationary economy and what impacts various scenarios for state appropriation of funds would have on the ultimate cost to the consumer.

If the thermal plan is implemented, dramatic changes in energy costs will likely occur. The effects of inflation coupled with continued escalation of fuel prices will mean higher prices for electric energy. The wholesale electricity price per kilowatt hour (kwh) in 1994 can be expected to be 145 mills (14.5¢) and will continue to rise. It is this price trend against which the Susitna project must compete for Susitna power to be marketable.

The sharply rising black line on Figure 12 traces the unit energy costs associated with the representative thermal plan. The dashed line above the thermal plan costs in the early years of project operation is associated with a Susitna case with no state participation. Susitna would be more costly to the consumer in its early years of operation than the thermal plan if the project was fully funded through the sale of bonds.

After about a dozen years, rising thermal plan costs intersect those for Susitna. After that, the thermal costs continue to rise while the Susitna costs become stable. Once project debts are amortized in 35 years, Susitna costs would drop dramatically for the remaining life of the project.

Several other financing options available to the State were analyzed by Acres. One of these is presented here as an example. This case is illustrated by the dotted line on Figure 12. This case assumes a State appropriation of $2.3 billion with no return on the State's contribution. It is anticipated that conventional bond financing would be used to provide the required funding over and above the State appropriation. A wholesale power rate would be set sufficient to pay debt service, operation and maintenance costs, and other costs related to the project. The $2.3 billion appropriation would be the minimum necessary to make the entry cost for Susitna comparable to that of the all thermal plan, with increasing cost savings occurring over the life of the project. The steep increase on the graph in 2002 reflects the Devil Canyon project coming on line and being financed entirely through the bond market.

Marketing Considerations

In the absence of any plans to merge existing Railbelt utilities into a central entity, it was assumed that various utilities will enter into contracts for Susitna energy if that energy is seen as the lowest cost alternative available for meeting demand. Under the cases shown on Figure 12 that incorporate a state contribution, purchase of Susitna energy would be found preferable to installing and operating new thermal plants either to meet demand or to replace retiring units.

The relatively large capacity associated with each successive stage of the Susitna project will inevitably lead to periods during which more capacity is available to the system than prudent reserve criteria would otherwise require. As a result, it may be anticipated that those thermal units which are most costly to operate will be shut down temporarily until demand rises once again to the point that additional capacity is needed. During wet years, hydroelectric energy production in excess of estimated firm energy output will be available at virtually no incremental costs, and it will be used to displace higher cost energy from some thermal plants which may be operated only during years of low flow.

Tidal not seen as major energy alternative for Railbelt

A recent report by Acres American prepared for the Office of the Governor showed that a tidal power plant on Cook Inlet is technically feasible. To assess the project's economic feasibility, the tidal alternative was compared with the conventional coal-fired generation system that may develop in the absence of a tidal or major hydroelectric project. Battelle Northwest also looked at tidal power, but did not include it in its analysis of electric power alternatives for the Railbelt because power costs would be substantially higher than for nontidal generation.

The conclusions of Acres' tidal report are:

- A tidal power plant is technically feasible to construct and operate;
- Because a tidal plant could not operate until at least the year 2000, some other means of generation would have to be developed to meet demand until then;
- If an industrial market for the intermittent tidal energy can be found, production of unretimed (not stored) tidal power appears competitive with a thermal generation plan; and
- If there is surplus energy, or if the energy must be retimed (stored), then the costs increase to 2 - 3 times that of coal.

Battelle's study concluded that:

- Although the cost of a fully utilized unretimed tidal plant would be competitive with thermal generation (coal-fired) plants, costs would not be competitive unless a specialized industry absorbed the predictable, but cyclic power output.
- Since, in the absence of such an industry, only a portion of the power from an unretimed tidal plant could be absorbed by the Railbelt system, the cost of this energy would be high relative to other generation options.
- Construction of a retiming facility, such as a pumped storage plant, would increase the costs of a tidal plant well above other generation options.

For these reasons, Battelle did not incorporate a tidal plant into their Railbelt electric energy plans.

Risks and environmental problems

Development of a tidal plant would not be without risks and environmental problems.

Tidal power development would lead to permanent changes behind the tidal barrier. Shoreline habitat would be altered. Natural processes of erosion, sedimentation, ice formation and movement, salinity distribution, and currents would change in complex ways. More detailed study is needed to determine the extent and long-term impact of these changes.

In addition, Acres singled out the following problems:

- Earthquake and tidal wave danger;
- Ice formation and movement behind the dikes;
- Lack of information about foundation conditions on the floor of Turnagain and Knik Arms; and
- Environmental constraints that could preclude storage of saline waters in natural or man-made reservoirs on mountains near the Inlet.

Pumped storage may be needed

Because tidal power is cyclic in nature, turning on and off with the flow of the tides, some type of storage or retiming of energy is usually necessary.

Acres estimated that about 40% of the tidal energy would be directly usable. The remainder would have to be retimed (stored) if an industrial user of the intermittent power were not found. The study assumed the construction of a pumped storage system would be necessary in the absence of such a user.

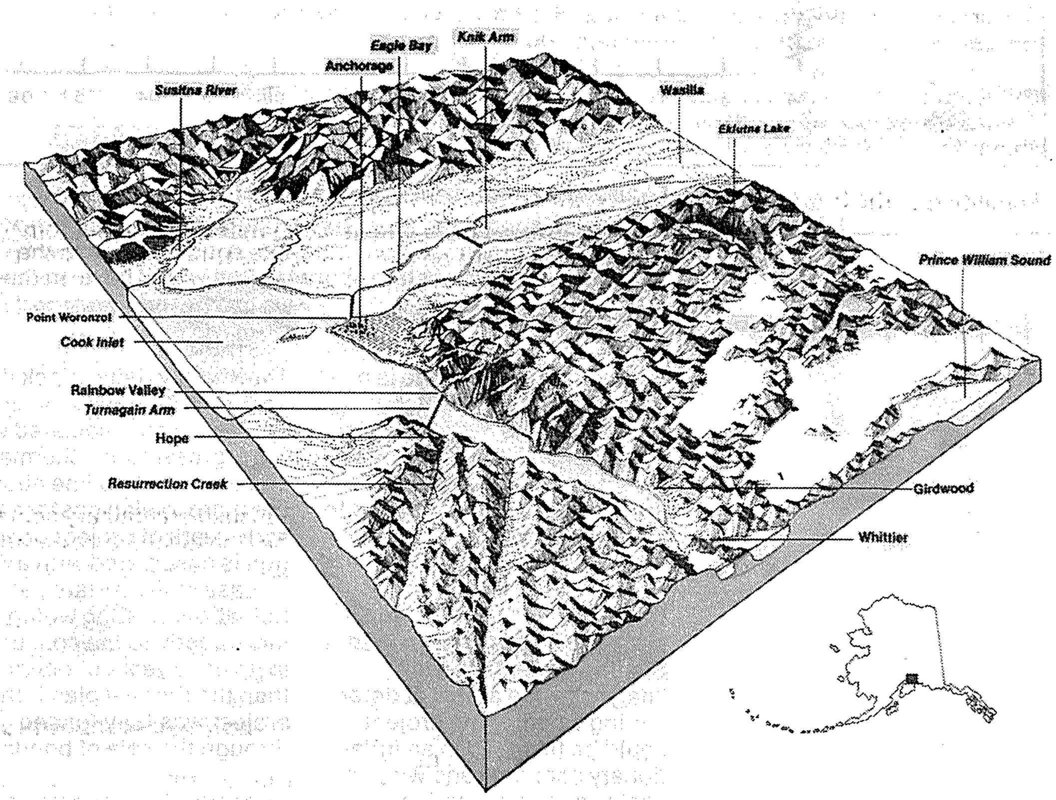
The pumped storage system would be located at a site, not specifically identified, in the mountains above Cook Inlet. When the tidal plant was generating, water would be pumped from Cook Inlet to this high reservoir using reversible turbines. It would be stored there until power was needed, then it would flow through turbines back into the Inlet when the tidal plant was not producing.

Phase II

A second study, Phase II Tidal Study, currently underway through the Governor's Office will further assess the economic feasibility of a tidal power plant. This study will investigate "the potential for industrial development in the Railbelt based on the availability and cost of electric power."

The types of industry that could use intermittent tidal power, as well as the possible availability of excess electrical power from other sources that might encourage industrial development, will be identified.

The results of this study should be available in June 1982. It will assist the Governor's Office in formulating a policy concerning the locating of industry in the Railbelt area.



Three points on the Knik and Turnagain Arms have been cited as potential locations for a tidal power plant:

- **across Knik Arm above Eagle Bay and Goose Bay (the preferred site);**
- **across Knik Arm between Point MacKenzie and Point Woronzof; and**
- **across Turnagain Arm at Rainbow.**

Source: Preliminary Assessment of Cook Inlet Tidal Phase 1 Volume 1 and 2, September 1981, prepared by Acres American, Inc. for the State of Alaska Office of the Governor.

How tidal power plants work

The need for electrical power is generally dictated by when people use it. Unfortunately, tidal power is only produced with the high and low cycles of the tide. These do not always coincide with the normal morning and evening peaking demands.

The available head (pressure) also varies from day to day and season to season.

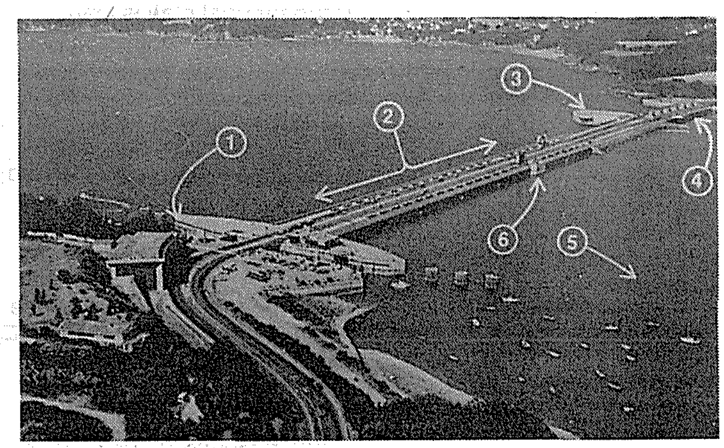
To efficiently harness tidal power, a dam is built across a bay or estuary to impound seawater in a basin to create the necessary pressure to turn turbine generators.

The enclosed basin is filled during the incoming tide. When the tide reaches its highest level, all gates are closed. The outgoing tide recedes, causing a pressure differential between the sea and the impounded seawater.

The seawater from the basin is then allowed to run out to sea through the turbine generators. This type of tidal plant utilizes sea flow in one direction and is called a single effect tidal plant.

Another type uses tidal power in both directions and is called a double effect tidal plant.

A third type exists when storage is added. This allows energy to be produced when the energy is needed, regardless of whether the tides are coming or going.



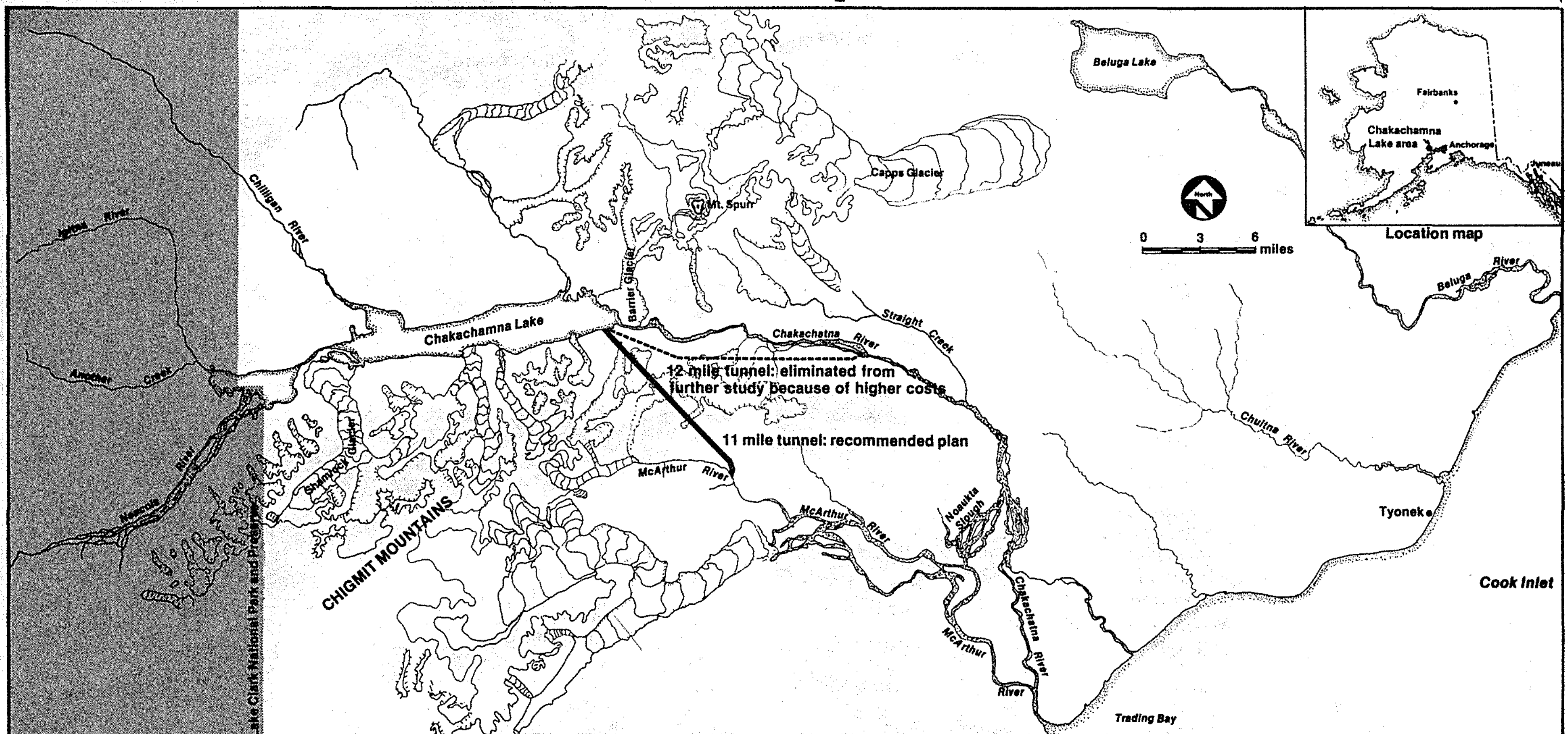
Aerial view of French tidal power plant, The Rance River estuary near Saint-Malo, France.

The tidal facility in France has a bridge across the top. This is similar in concept to what a Knik Arm tidal facility might look like. It could provide a base (the dam itself) over which roads or railways could cross Knik Arm.

Legend
1. A ship lock for navigation. 2. The dam structure with bridge on top and turbines underwater. 3. A rock-fill dike. 4. A sluiceway dam section with six gates. 5. The storage basin. 6. A control bay.

Source: "Cheap Electricity from French Tides," IEEE Spectrum, Volume 17, Number 2, February 1980.

Chakachamna Lake hydro project included in two of Battelle's "without Susitna" plans



The Chakachamna Lake area is located 85 miles west of Anchorage and 40 miles west of Tyonek. The lake and its major river outlet, the Chakachatna River, are situated between the Alaska Range and upper Cook Inlet, where the Chakachatna flows into Trading Bay.

The project is in an active, changing area with a number of glaciers and an active volcano. Barrier Glacier forms the eastern end of the lake.

The terminus, or toe, of the glacial moraine constricts the Chakachamna outlet. There are several smaller glaciers on the south side of the lake and the Shamrock Glacier is located at the west end.

According to the U.S. Geological Survey, the level of Chakachamna Lake rose about 1 foot per year from 1959 to 1971 as Barrier Glacier advanced, raised the lake's outlet and moved the outlet channel toward the Chigmit Mountains. A combination of high flows and an increase in slope at the outlet channel caused movement of the large boulders lining the channel and eventual erosion of the ice. The result was a massive flood of 470,000 cfs that lowered the lake level about 14 feet.

Mt. Spurr, an active volcano, rises 11,000 feet above the eastern end of Chakachamna Lake. The most recent eruption of Mt. Spurr was in 1953. The eruption caused a debris flow that dammed the Chakachatna River just below Chakachamna Lake, causing the river to back up over the lake. The debris barrier eroded shortly after the eruption leaving a small impoundment below the lake in the Chakachatna River valley.

Hydroelectric development at Chakachamna Lake on the west side of Cook Inlet has been included in two of Battelle's electric energy plans for the Railbelt.

In Plan 1A, conventional generation without the Susitna project, it is the largest hydroelectric project.

In Plan 2A, high conservation and use of renewable resources without Susitna, the Chakachamna project forms the core of a "decentralized" hydroelectric alternative.

Clearly the Chakachamna project is an important energy source that could figure prominently in the Railbelt's energy future.

Current study

Bechtel Civil and Minerals, Inc., of San Francisco is currently conducting a feasibility study of the Chakachamna Lake project for the Alaska Power Authority. The study began in August 1981 and, depending on legislative funding, will continue through March 1983 when a FERC license application could be submitted, if the project was to be pursued.

The Chakachamna project would differ from the plan for Susitna because Chakachamna would involve a lake tap, and no dam. This means a tunnel would be bored into the lake below the water's surface and water from the lake diverted to a powerhouse. This is similar to existing hydro developments at Eklutna Lake and Cooper Lake.

Two tunnel alternatives

Two tunnel alternatives have been evaluated. The first is an 11 mile long tunnel from the lake southeasterly to the McArthur River. The second is a 12 mile long tunnel easterly down the Chakachatna River valley. Either tunnel would be about 25 feet in diameter, making the project one of the largest lake tap developments in the world.

Because preliminary costs of the Chakachatna powerhouse option were higher than the McArthur option, further studies would focus on the preferred McArthur River tunnel.

Potential power production

The McArthur River tunnel has the option of diverting all or a portion of the water stored in the lake to a powerhouse. If all the available water was diverted from Lake Chakachamna to the McArthur powerhouse site, an average of 1752 GWH of energy could be produced annually and 400 MW of capacity provided.

If this were done, the flow in the Chakachatna River just below the lake outlet would be completely eliminated. The substantial anadromous fishery that uses the lake and its tributaries for spawning would be lost. The salmon which use the lower Chakachatna would also be impacted because of reduced flow.

To reduce downstream impacts, an alternative was developed in which a portion of the flow into the lake would be released into the Chakachatna River below the existing outlet. This would reduce the installed capacity of the project to 330 MW and would reduce energy production to 1446 GWH in an average year.

To mitigate the impacts occurring to the fish that use the lake and its tributaries, fish passage facilities would have to be constructed in order to permit the fish to pass in and out of the drawn down lake. This reduced power alternative is the plan that has been selected for further study.

Preliminary cost estimates compared to Susitna cost estimates

Bechtel has developed preliminary cost estimates for the Chakachamna project. The level of confidence in the accuracy of these costs is substantially less than that of the Susitna project costs because more detailed site investigations and analysis have been conducted on the Susitna project to date.

Bechtel estimates a total project cost of $1.45 billion in January 1982 dollars.

In terms of capital costs only, the cost of energy from Chakachamna would be about 24% higher than the anticipated cost from the Susitna two-dam project. And, because the project is much smaller than Susitna, the balance of the Railbelt energy needs would have to be met by other means.

If it were decided to construct both projects, constructing Chakachamna initially and postponing Susitna development, the result would be an estimated $1 billion increase in the present value of system costs when compared to the recommended Susitna plan.

Studies document presence of all five species of Pacific salmon

Limited field study conducted primarily in September 1981 has documented the presence of all five species of Pacific salmon in both the McArthur and Chakachatna Rivers.

At the time of the survey, adult sockeye was the most common salmon species present. Information on run size was not collected during this brief survey. Consequently, no estimates of escapement were made.

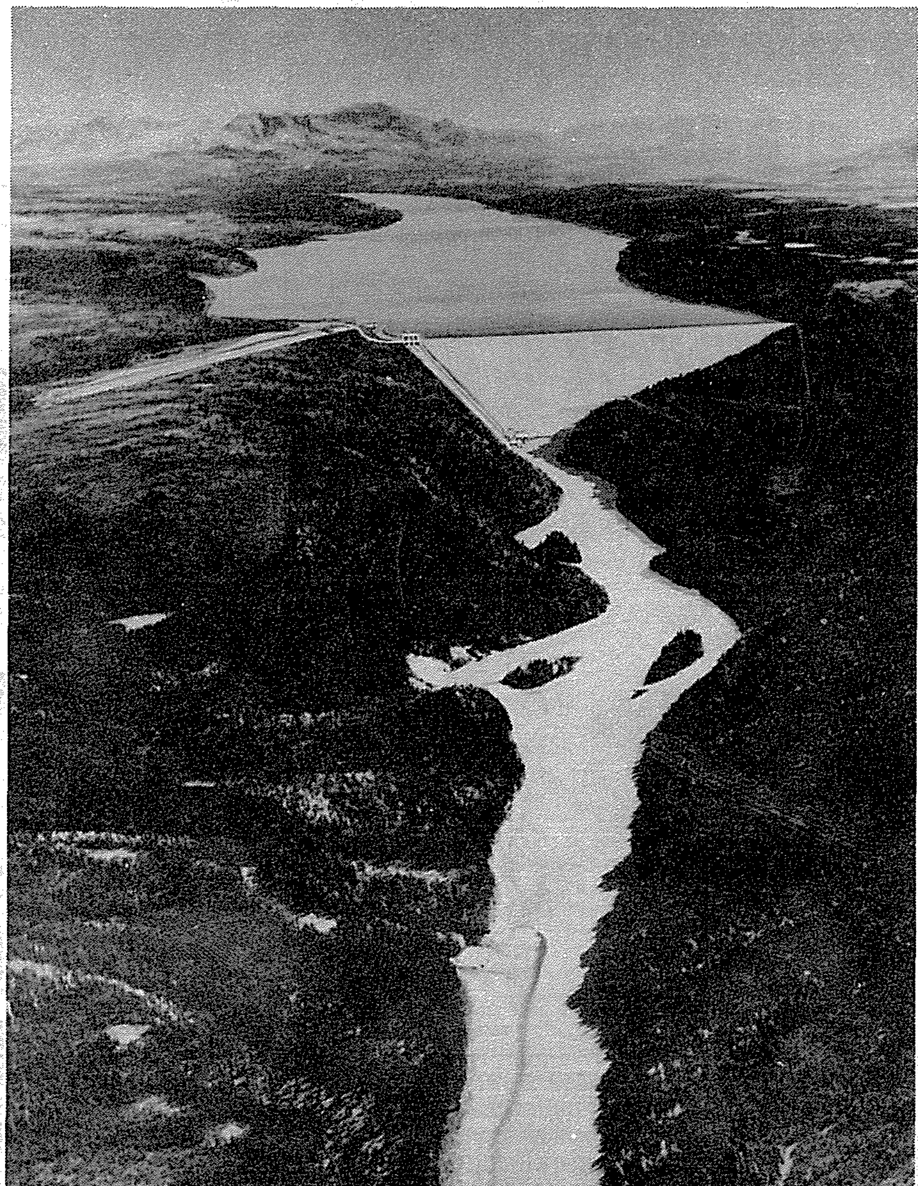
During the two week survey, estimates of adult sockeye were made. Above the lake, the Chilligan and Igintna Rivers were each estimated to have 10-20,000 sockeye. Below the lake, 1500 to 3000 sockeye were estimated in the main stream Chakachatna. Additionally 1000 to 2000 sockeye were estimated in the Mc Arthur River. From this very preliminary data, it appears that there is a sizeable sockeye run in both the Chakachatna and Mc Arthur systems.

Further Study

If the legislature provides funding for FY 1983, detailed studies of the fishery including distribution, abundance, and habitat will be conducted, along with the engineering and design aspects.

The data from the detailed fisheries studies, as well as other environmental studies, would be used to evaluate changes expected from the construction and operation of the project. Detailed mitigation plans would also be developed as part of the future studies to determine the project's feasibility.

Source: Chakachamna Hydroelectric Project Interim Report, November 30, 1981, prepared by Bechtel Civil and Minerals, Inc. for the Alaska Power Authority.



These are photo renditions of the major structures at the proposed Watana (left) and Devil Canyon (right) dam sites. Several features are not shown, including: the permanent townsite; the access road; transmission lines; substations; and a runway for aircraft.

The Watana dam would be an earth-fill structure 885 feet high, 4100 feet long, with an installed capacity of 1020 MW. The Devil Canyon dam would be a concrete arch dam 645 feet high, about 1500 feet long at the crest, with an installed capacity of 600 MW. The Watana dam would create a reservoir 48 miles long; Devil Canyon a reservoir 26 miles long.