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Susitna Hydropower Plan of Study

DEPARTMENT OF THE ARMY
ALASKA DISTRICT, CORPS OF ENGINEERS
P.O. BOX 7002
ANCHORAGE, ALASKA 99510

REPLY TO
ATTENTION OF:
NPAEN-US

28 June 1978

Mr. Eric Yould
Executive Director
Alaska Power Authority
333 West 4th - Suite 31
Anchorage, Alaska 99501

Dear Mr. Yould:

I am pleased to submit in response to your 19 January letter the final Susitna Plan of Study prepared by the Alaska District, Corps of Engineers, for the State of Alaska, under provisions of Title 3, the Intergovernmental Cooperation Act of 1968.

The report incorporates the comments developed by other State agencies, which you provided, in particular those prepared by the Department of Fish and Game. As a result, the intensity of some of the biological studies has been expanded to help identify the magnitude of the resources that will be affected by the Susitna project. The total increase is $1,886,000 for biological activities.

To offset some of this increase, activities under the categories of survey and foundation and materials have been decreased as the result of the exercise presently under way at the Watana damsite in obtaining information as requested by the President's Office of Management and Budget (OMB). To respond to OMB's review comments on the 1976 Feasibility Report, test borings and geological data are being compiled which reduced the content of several activities outlined in the September 1977 POS draft. This reduction amounted to $1,150,000 which helped hold the overall cost increase to $736,000. The total study cost is now $24.1 million. The price level index was held at September 1977.

The Plan of Study retained the 46-month period to conduct the project feasibility studies based on a 1 May start. Several months of advanced preparation will be required before initiating the activities to allow

early mobilization of a camp facility and commence other contract activity actions to assure implementation at the beginning of the summer field season.

The studies will insure optimal basin and system generation planning along with a reasonably accurate cost estimate for the first phase of basin development. These studies represent approximately 25 percent of the total engineering and design effort envisioned for a two-dam complex.

The activities defined in this document have been developed to adequately address determination of project feasibility. The project feasibility analysis program does include suggestions and comments received from various agencies, both Federal and State, and I feel that the program will provide the information necessary for the State to determine desirability of proceeding into construction of a hydroelectric facility in the upper Susitna River basin.

Sincerely yours,

George R. Robertson

GEORGE R. ROBERTSON
Colonel, Corps of Engineers
District Engineer

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PLAN OF STUDY
for
SUSITNA HYDROPOWER
FEASIBILITY ANALYSIS

PREPARED FOR THE STATE OF ALASKA

BY

ALASKA DISTRICT

U.S. ARMY CORPS OF ENGINEERS

JUNE 1978

ARLIS
Alaska Resources
Library & Information Services
Anchorage, Alaska

ACKNOWLEDGEMENTS

This plan of study for Susitna hydroelectric project feasibility planning was prepared with the assistance of personnel from the North Pacific Division, Corps of Engineers; the Seattle, Portland, and Walla Walla Corps of Engineer Districts; the U.S. Army Cold Regions Research and Engineering Laboratory; the U.S. Army Corps of Engineers Waterways Experiment Station; the U.S. Geological Survey; and the Geophysical Institute of the University of Alaska as well as the State agencies that reviewed and commented on the draft. Each of these agencies contributed valuable input in their respective fields of expertise. Also, the numerous comments offered by agencies, groups, and individuals during previous feasibility studies of hydroelectric development on the Susitna River were helpful in formulating this program of additional study.

Cover photo, showing Portage Creek 3 miles downstream from Devil Canyon Damsite, from the Alaska Department of Fish and Game.

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EXECUTIVE SUMMARY

This plan of study (POS) prepared by the Alaska District Corps of Engineers for the State of Alaska presents a program of activities for project feasibility analysis of hydropower development in the Upper Susitna River Basin. It provides a description of each activity along with a cost estimate for its completion. The POS fulfills a Federal planning requirement while also providing the State of Alaska an overview of the planning activities associated with a large scale water resource project. The authority for proceeding with this joint State-Federal planning program is contained in Section 203 of the Water Resources Development Act of 1976 enacted by the 94th Congress. Funding for preparation of the POS was provided by the State of Alaska on 30 June 1977.

Existing electrical generation within the study area is produced almost exclusively by fossil fuel thermal resources. However, as these resources become more scarce, and perhaps very expensive, and as the energy demand increases to a projected 15 billion kilowatt hours by the year 2000, the advantage of non-cost-inflating, renewable energy, such as hydropower, becomes apparent. A feasibility report completed by the Corps of Engineers in 1976 outlined a number of alternative plans for developing the hydropower potential of the Upper Susitna Basin and identified the most economical plan, consisting of a system of two dams--a 635-foot-high concrete thin arch dam at Devil Canyon and an 810-foot-high earthfill dam at Watana, with 365 miles of transmission line. This system is capable of developing 6.1 billion kilowatt hours of firm annual energy, roughly triple the energy consumed in Anchorage and Fairbanks in 1974. While the 1976 feasibility report provided sufficient data to support the need and economic feasibility of a plan to develop the hydroelectric potential of the Upper Susitna Basin, it was recognized that additional field data and more detailed studies would be required. The POS outlines the additional studies required to determine the most cost-effective plan, and its environmental impacts.

The activities outlined in the POS have a total estimated cost of $24.1 million over a time frame of 46 months. The schedule is based on early notification of program initiation and timely receipt of study funds to allow mobilization for field explorations prior to

the summer season and arrangements for access to the sites. A critical path method network (CPM) shows the interrelationship of some 202 activities and indicates those activities and timing most critical for completion of the project feasibility analysis. Early acquisition of field data about foundation conditions, stream flows, and topographic surveys during the short summer months is very important.

Study management of physical and fiscal progress must be rigorously maintained throughout the 46-month period. Periodic progress reports and a report of expenditures would be provided the State of Alaska for their information and review. The project feasibility analysis activities have been programmed through three progressive steps: (1) preliminary screening, (2) detailed feasibility studies, and (3) detailed design studies for Watana, access road, and transmission system.

Preliminary Screening: In step 1 of the study, a number of potential damsites and combinations of different dams and heights would be evaluated to identify the most economical and environmentally acceptable plan based on a preliminary calculation of benefits and costs. During this study phase, the best plan identified in the 1976 feasibility report, Watana constructed initially followed by construction of Devil Canyon, would be reexamined. This first step is estimated to cost $4.3 million and be completed in 7 months. In order to meet the overall study schedule of 46 months, field work needed in later phases of the study has been scheduled concurrently with the preliminary study phase and these costs are included in the subtotal of $4.3 million. Results of the preliminary phase will provide the first important decision point as to whether the study should continue into the second step of detailed feasibility studies.

Detailed Feasibility Studies: Detailed studies would be concentrated on the best plan identified in the preliminary screening. Costs and benefits would be refined using more accurate data obtained from ongoing field work. This second step is estimated to cost $16.7 million and be completed in 25 months after completion of the initial step. As indicated above, additional field work would continue during this phase of the study and these costs have been included in the subtotal of $16.7 million. Also included are concurrent activities required for detailed design studies. Completion of the detailed feasibility report will provide a firm basis for recommending for or against construction of the project, whether Federally funded, State supported under Section 203, or totally financed by the State of Alaska.

Detailed Design Studies: Assuming a favorable showing of feasibility in step 2, the last step would be detailed design of any dams, powerhouses, access roads, and some 365 miles of double circuit transmission lines and substations to deliver power to the Anchorage and Fairbanks

load centers. A detailed and accurate cost estimate for construction of the initial element in a dam system will be provided to enable a decision on funding and initiation of construction. The third step is estimated to cost $3.1 million and be completed in an additional time frame of 14 months after completion of step 2.

The above estimates of cost and time for completion of the three steps are based on the findings and recommendations contained in the 1976 feasibility report, and envision a continuation of that planning study leading to the ultimate construction of the project.

At the end of any of the three program steps, Susitna hydroelectric development could be determined to lack economic or environmental justification. Such a conclusion would result in the termination of the planning program and in Federal assumption of responsibility for expended funds. Otherwise, the study costs would be borne by the State of Alaska. Assuming a favorable recommendation, detailed plans and specifications for the first construction contract could be undertaken immediately thereafter.

PURPOSE

The function of the plan of study is to delineate the engineering, economic, social, and environmental studies associated with planning for the Upper Susitna River Basin hydroelectric project, as a prelude to State participation under Section 203 of the 1976 Water Resources Development Act. The study will provide a description of activities to be performed, an estimate of cost and time for accomplishment of these activities, an indication of the activity interdependence, and a schedule of program activities that can serve as a management tool during the study effort. Should the State of Alaska desire to work toward development of the Upper Susitna Basin outside the provisions of the 1976 Water Resource Development Act, the plan of study will serve as a guide in assessing other proposals for analyzing the economic feasibility and environmental impact of the project.

AUTHORITY

The Corps of Engineers is participating in accordance with a Memorandum of Understanding, dated 30 June 1977, between the United States of America and the State of Alaska for preparation of a "Study Outline, Susitna Project." The memorandum directs that,

> "The Secretary of the Army, acting through the District Engineer, Alaska, shall prepare a study outline for the Susitna Project for the purpose of detailing the Scope of Work required to provide engineering, environmental, economical, and social information relating to the subject project under the provisions of Title 3, Public Law 90-577, 16 October 1968, the Intergovernmental Cooperation Act of 1968."

Studies considered in the Plan of Study were authorized by Public Law 94-587, entitled "Water Resources Development Act of 1976" enacted by the 94th Congress on 22 October 1976.

The authorizing legislation provided for two options for the conduct of Phase I studies. Section 160 states that,

> "The Secretary of the Army, acting through the Chief of Engineers, is authorized to undertake the Phase I design memorandum stage of advanced engineering and design of the project for hydroelectric power on the Susitna River, Alaska, in accordance with the recommendations of the Board of Engineers for Rivers and Harbors in its report dated June 24, 1976, at an estimated cost $25,000,000. This shall take effect upon submittal to the Secretary of the Army by the Chief of Engineers and notification to Congress of the approval of the Chief of Engineers."

The possibility for State of Alaska funding of Phase I studies is provided for by Section 203(e) which states,

> "The Secretary is authorized to make expenditures from the [Alaska Hydroelectric Development Fund] for the Phase I design memorandum stage of advanced engineering

and design for any project in Alaska that meets the requirements of Subsection (a)(2) of this Section, if appropriate non-Federal public authorities, approved by the Secretary, agree with the Secretary, in writing, to repay the Secretary for all the separable and joint costs of preparing such design memorandum, if such report is favorable. Following the completion of the Phase I design memorandum stage of advanced engineering and design under this subsection, the Secretary shall not transmit any favorable report to Congress prior to being repaid in full by the appropriate non-Federal public authorities for the costs incurred during such Phase I. The Secretary is also authorized to make expenditures from non-Federal funds deposited in the fund as an advance against construction costs."

Funds were provided for preparation of the Plan of Study by the State of Alaska on 30 June 1977.

PROBLEMS & NEEDS

Most of the present commercial electrical power in the Southcentral Railbelt area is derived from fossil fuel thermal and turbine generation. The Anchorage-Cook Inlet area had a total installed capacity of 504.8 megawatts (MW) in 1976. Natural gas fired turbines were the predominant energy source with 434.9 MW of installed capacity. Hydroelectric capacity of 45 MW was available from the Eklutna and Cooper Lakes projects. Steam turbines comprised 14.5 MW of capacity, and diesel generation, mostly in standby service, accounted for the remaining 10.4 MW.

The Fairbanks-Tanana Valley area commercial utilities had a total installed capacity of 222.2 MW in 1976. Oil-fired gas turbine generation provided the largest block of power with a capacity of 136.6 MW. Steam turbines provided 53.5 MW of power and diesel generators contributed 32.1 MW.

Recent electrical power growth rates have been in the neighborhood of 14 percent annually, and although these rates are projected to decline to 7 percent beyond 1980, the year 2000 Railbelt power requirements are estimated to be 15 million megawatt-hours energy and 3,170 megawatts peaking capacity.

Estimated Railbelt Area Power Requirements

	1976	1980	1990	2000
Capacity (MW)	569	870	1,670	3,170
Energy (GWH)	2,550	3,980	7,620	15,000

While increased power capability is the need which precipitated the 1972 U.S. Senate Committee on Public Works resolution which authorized the Corps of Engineers feasibility study, other problems and needs have also been identified. These include the need to preserve natural areas, to conserve or enhance fish and wildlife resources, to respond to problems of flood damage and air pollution, to expand recreation opportunities, and to conserve fossil fuels.

It would be presumptuous to assume that any single water resources plan could satisfy all the water-related needs of a region. Even if the plan could respond to the full range of water-related problems, there are often economic, social, and other needs that must be recognized. It is therefore necessary to select a more limited set of compatible needs to which the water resources plan can respond. In other words, the extent to which desirable functions of a multipurpose project could be developed is highly dependent upon which various purposes are compatible.

Needs which the project development could help satisfy, but which may be contrary to the objective of power development, include the improvement of small boat and deep draft navigation conditions, augmentation of municipal water supplies, and development of an extensive irrigation system. The plans for power development are also relatively unresponsive to the desire for preservation of what could be termed the "Alaskan way of life," including prevention of further population growth, prevention of additional industrialization, and curtailment of urban expansion.

PROJECT DESCRIPTION

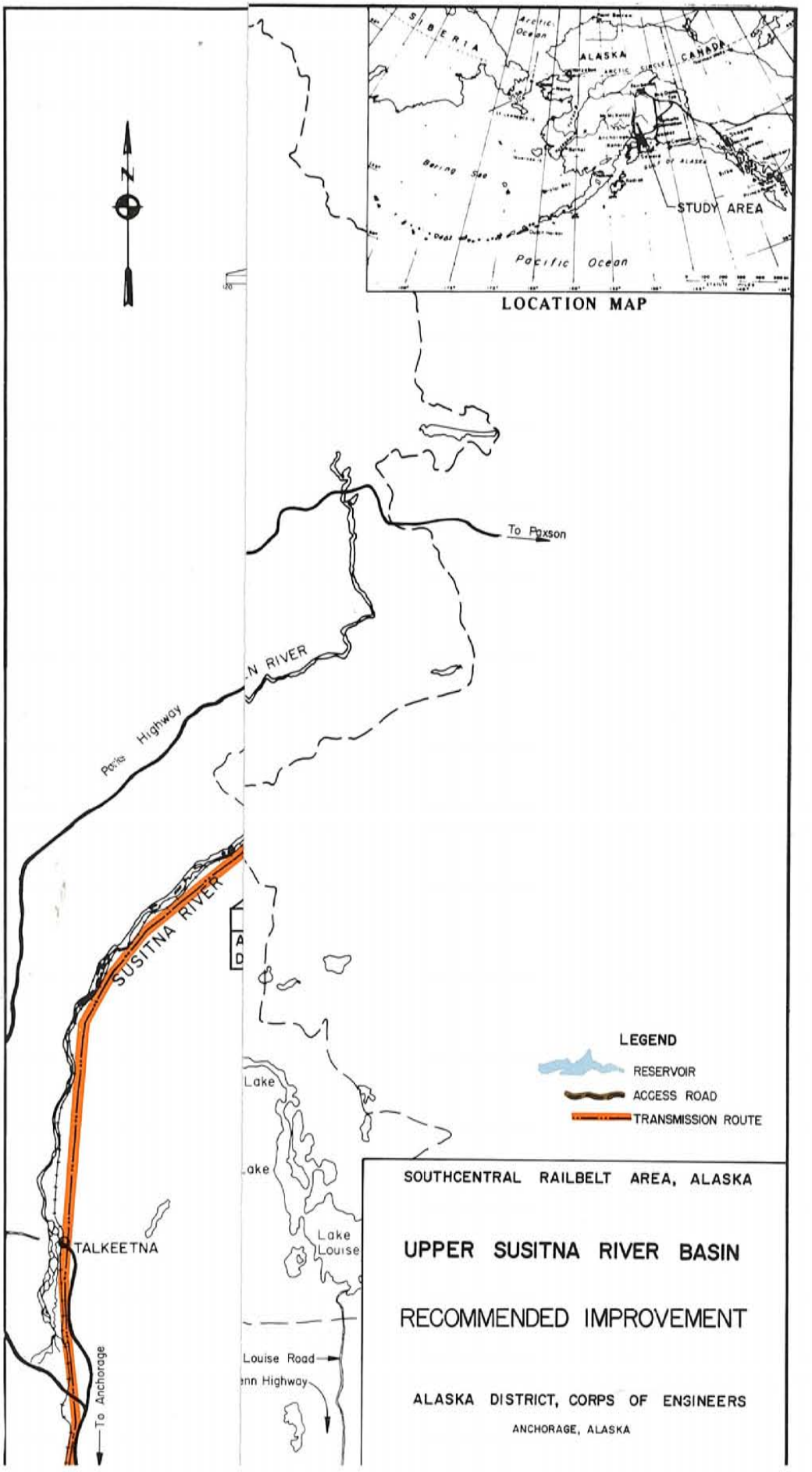
The plan of development recommended by the Corps of Engineers in 1976 consists of two dams and related reservoirs and powerplants to be constructed on the Upper Susitna River with transmission facilities to provide power to the Anchorage and Fairbanks load centers.

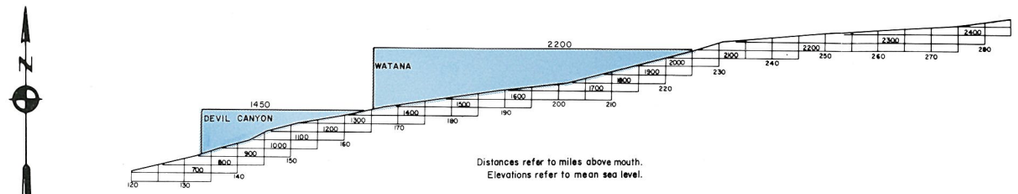
Watana and Devil Canyon were the two projects recommended in 1976. These two projects could produce 6.1 billion kilowatt hours (kWh) firm annual energy, 800 million kWh average annual secondary energy, and 1,392,000 kilowatts of dependable capacity based on a 50 percent system load factor. Watana, the first project to be built under this plan of development, would consist of an 810-foot-high earthfill structure located at river mile 165. The reservoir would extend 54 miles upstream and have a surface area of 43,000 acres. The total storage capacity would be 9,624,000 acre-feet after 50 years of sediment inflow. The useable storage capacity would be 6,100,000 acre-feet. Devil Canyon, 32 miles downstream of Watana, would be a concrete thin-arch dam with a maximum structural height of 635 feet. Construction of the Devil Canyon project after completion of Watana would be phased to meet the projected electrical energy demands of the Railbelt area. The Devil Canyon reservoir would inundate 7,550 acres and 28 miles of natural river, and would provide 1,050,000 acre-feet of storage capacity. Intake structures would be situated to allow a maximum power pool drawdown of 175 feet, but when operated in conjunction with the upstream Watana reservoir, Devil Canyon annual drawdown would normally be less than 5 feet.

The transmission line would be approximately 365 miles in length consisting of double towers, each carrying a single conductor three-phase circuit. About 25 percent of the energy would be provided to the Fairbanks load centers, with 75 percent being utilized in the Anchorage area. A basin map shows the location of the two dams (Figures 1 and 2). Detailed layouts of Devil Canyon and Watana are shown on Figures 3 and 4.



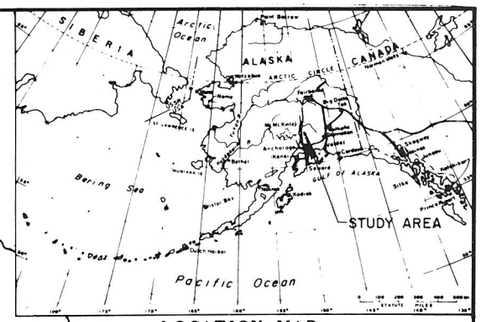
FIGURE 1. ERTS satellite photograph of the Upper Susitna River with the general location of the Devil Canyon and Watana Projects shown in the circles. Devil Canyon project, on the left, is roughly 65 miles upstream from Talkeetna, and Watana is 32 miles above Devil Canyon. Shown in the upper right corner of the photo are the glaciers of the Alaska Range, which provide much of the flow for Susitna River.


SIBERIA
Arctic Ocean
ALASKA
CANADA
Bering Sea
STUDY AREA
Pacific Ocean
LOCATION MAP
N
To Paxson
N RIVER
Parks Highway
SUSITNA RIVER
Lake
ake
Lake Louise
TALKEETNA
To Anchorage
Louise Road
nn Highway
LEGEND
RESERVOIR
ACCESS ROAD
TRANSMISSION ROUTE
SOUTHCENTRAL RAILBELT AREA, ALASKA
UPPER SUSITNA RIVER BASIN
RECOMMENDED IMPROVEMENT
ALASKA DISTRICT, CORPS OF ENGINEERS
ANCHORAGE, ALASKA



UPPER SUSITNA RIVER PROFILE

RIVER MILES 120–290



LOCATION MAP

BASIN BOUNDARY

RECOMMENDED
A DAM AND RESERVOIR AT WATANA DAMSITE WITH TRANSMISSION FACILITIES.

RECOMMENDED
A DAM AND RESERVOIR AT DEVIL CANYON DAMSITE.

To Fairbanks
Parks Highway
Alaska RR
Devil Canyon Access Road (Proposed)
Portage Creek
Devil Creek
DEVIL CANYON DAMSITE
GOLD CREEK
Chase Creek
Chulitna River
SUSITNA RIVER
TALKEETNA
To Anchorage
Tsusena Creek
Deadman Creek
Watana Creek
Watana Access Road (Proposed)
Fog Creek
WATANA DAMSITE
SUSITNA RIVER
Kosina Creek
Jay Creek
Coal Creek
MACLAREN RIVER
To Cantwell
West Fork
East Fork
Valdez Creek
DENALI
Windy Creek
Butte Creek
Denali Highway
To Paxson
TYONE RIVER
Tyone Lake
Susitna Lake
Lake Louise
Lake Louise Road
To Glenn Highway
OSHETNA RIVER
BASIN BOUNDARY

SCALE
0 5 10 15 20 Miles

LEGEND
- RESERVOIR
- ACCESS ROAD
- TRANSMISSION ROUTE

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

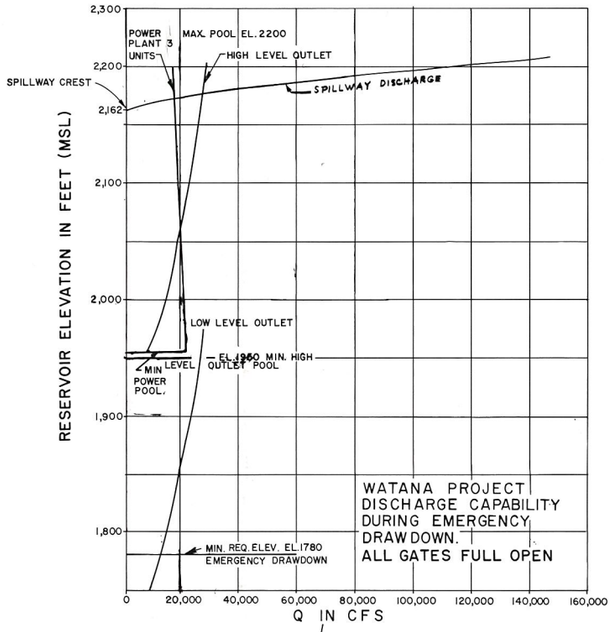
RECOMMENDED IMPROVEMENT

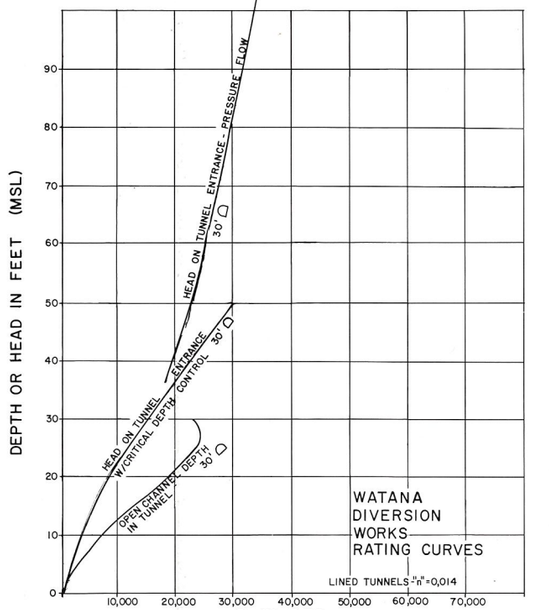
ALASKA DISTRICT, CORPS OF ENGINEERS
ANCHORAGE, ALASKA

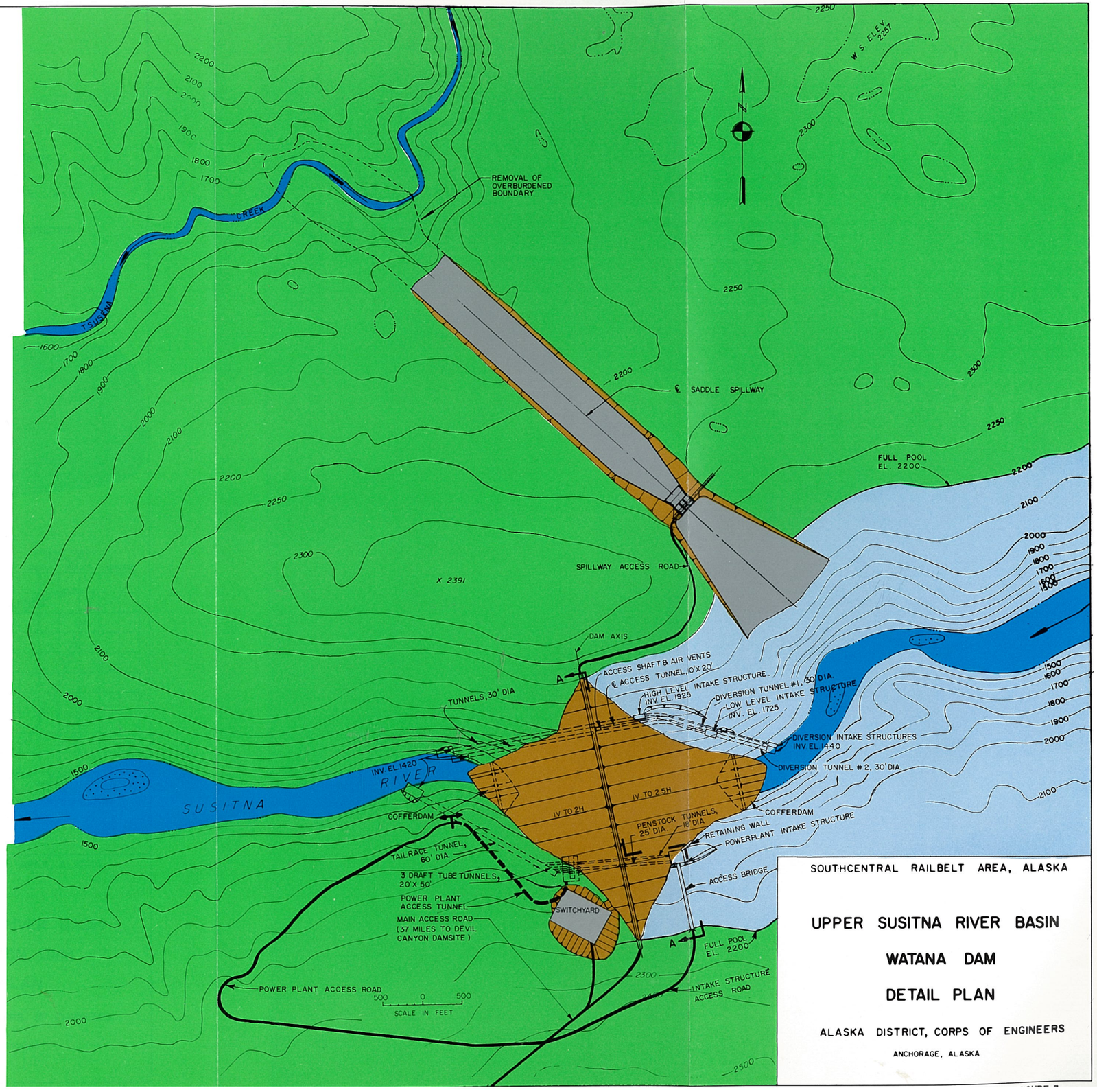
NOTES:

1. TOPOGRAPHIC CONTOURS WERE TAKEN FROM U.S.G.S. TOPOGRAPHY SCALE 1:63,360, TALKEETNA MOUNTAINS (D-4), ALASKA. VERTICAL DATUM IS MEAN SEA LEVEL (M.S.L.).

2. THERE ARE NO KNOWN EXISTING IMPROVEMENTS ON THIS PLATE.







SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

WATANA DAM

DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

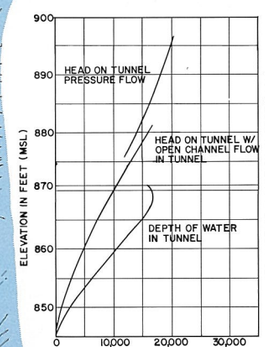
ANCHORAGE, ALASKA

776 MW POWER PLANT CHAMBER
POWER PLANT ACCESS ROAD
POWER PLANT ACCESS ROAD TUNNEL
℄ 18' DIA. PENSTOCK
GATE CHAMBER
CONTRACTION JOINTS
DOWNSTREAM FOUNDATION TREATMENT CONCRETE
AXIS OF DAM
℄ 24' DIA. PENSTOCKS (2)
ELEVATOR TOWER
ADIT TO GALLERY IN DAM
LOW LEVEL EMERGENCY SLUICES
REFERENCE PLANE N 80°00' W.
℄ DRAFT TUBES
COFFERDAM TOP EL. 890
26' DIA. DIVERSION TUNNEL
COFFERDAM TOP EL. 900
DIVERSION INTAKE
SERVICE SPILLWAY
SUSITNA RIVER
OLD FOOT BRIDGE
OLD AIRSTRIP
E 9,000
N 11,000
UNDERGROUND CABLE
4-60' CONC. GRAVITY MONOLITHS
THRUST BLOCK SECTION
EARTHFILL SECTION
EXCAVATE TO EL. 1340
EXISTING STRUCTURE
EL. 1410 ±
SWITCHYARD
1V ON 2.5H
1V ON 2.5H
CREST EL. 1461
EXISTING ROAD (4 WHEEL DRIVE)
100 0 100 200
SCALE OF FEET
SWITCHYARD ACCESS ROAD
MAIN ACCESS ROAD (27 MILES TO ANCHORAGE — FAIRBANKS HIGHWAY 3)
E 10,000
N 9,000
TO GOLD CREEK

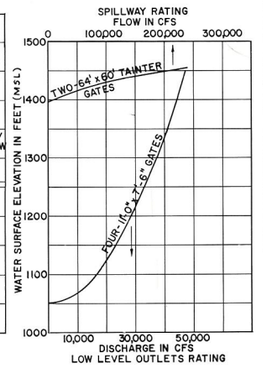
NOTES:

1. TOPOGRAPHY WAS COMPILED FROM AERIAL PHOTOGRAPHY WITH GROUND CONTROL. VERTICAL DATUM IS MEAN SEA LEVEL, (m.s.l.).

2. EXISTING IMPROVEMENTS WERE CONSTRUCTED TO OBTAIN INFORMATION AND DATA FOR EARLIER STUDIES.



DEVIL CANYON 26' ∩ DIVERSION TUNNEL



DEVIL CANYON RATING CURVES

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN
DEVIL CANYON DAM
DETAIL PLAN

ALASKA DISTRICT, CORPS OF ENGINEERS

ANCHORAGE, ALASKA

ENVIRONMENTAL SETTING

TOPOGRAPHY

The Upper Susitna River Basin contains several topographic features which provide a conglomerate stream flow heavily influenced by specific meteorological events. The basin was shaped by volcanism, diastrophism, glacial erosion, and marine deposition. The basin, as shown in Figure 1, is a fan-shaped area comprising about 6,160 square miles and is bordered by the Alaska Range to the north, the Talkeetna Mountains to the southeast, and flat, low-relief areas to the southwest.

Most of the basin has a well-defined branching stream pattern with a main channel emanating from glacial headwaters in the extreme northern segment of the divide. Below the glaciers, the braided stream traverses a high plateau composed of aggraded alluvial sediment, and then meanders several miles south to the confluence with the Oshetna River. It then takes a sharp turn to the west and flows through a steeply cut, degrading channel until it exits the basin at Gold Creek. The contributing glacial area comprises only 4 percent of the entire basin, but summer glacial melt provides a considerable portion of the total streamflow. By contrast, the flat, glacially carved Lake Louise area in the southeastern portion of the basin provides comparatively little flow from its 700-square-mile area.

The mountains within the basin reflect the influence of the Pleistocene Ice Age, during which glacial advancement over the topography planed the mountains and gave the basin surface a rounded and smoothed appearance. The highest elevation within the basin is 13,326 feet, and the lowest elevation is 740 feet. The basin relief implies a steep channel slope; however, variability of the slope compared to other mountain streams is somewhat reversed. The aggraded channel in the upper reaches of the basin has channel slopes in the range of only 4 to 7 feet per mile, while the lower basin channel drops as much as 37 feet per mile.

Main tributaries to the Susitna River have an even higher range of channel slopes. The deeply incised river channel below the Tyone River contrasts with the many traditional Alaskan U-shaped valleys, remnants

of glacial advances. The absence of broad flood plains in the lower basin results in high stages during high runoff due to confined flow areas. The Susitna River alluvium has developed into a continuous effluent aquifer. Most of the tributary aquifers do not sustain winter flow.

CLIMATE

The climate of the Upper Susitna Basin is characterized by cold dry winters and warm but moderately moist summers. The yearly precipitation distribution shows that 64 percent of precipitation occurs from June through October. Within the Railbelt area, the climate falls into three categories: (1) a zone dominated almost entirely by maritime influences, (2) a zone of transition from maritime to continental climatic influences, and (3) a zone dominated by continental climatic conditions. The Upper Susitna Basin falls within the transitional zone. The contrast between the maritime-influenced areas of the southern Kenai Peninsula and the continental conditions at Fairbanks is marked. Within the confines of the Upper Susitna Basin, away from the moderating influence of maritime air, there are greater temperature extremes than on the coast of the Gulf of Alaska. Extreme winter temperatures are caused by polar air masses which flow in from the north.

Mean annual precipitation in lower elevations of the basin would be expected to range between 18 and 22 inches, while precipitation in higher elevations, because of orographic effects, would be expected to reach 80 inches per year. Mean annual snowfall would range from 60 inches in the lowlands to as much as 400 inches in the high mountains. Freezeup in the highest reaches of the Susitna River starts in early October, and by the end of November the lower regions of the river are icebound. The river breakup begins in early May, and within two weeks of breakup the river tributaries are free of surface ice.

BASIN STREAMFLOW

The annual streamflow patterns of the Upper Susitna River and most of its tributary streams are best described as providing perennial flow. The main tributaries of the Susitna River consist of the East and West Fork Susitna Rivers which originate in the northern section of the drainage basin, the Maclaren River which originates in the northeastern portion of the basin, and the Tyone River which emanates from the southern reaches of the basin.

The flow regime of the Susitna River is seasonal, with more than half of the yearly streamflow occurring from May through September. Summer streamflow consists mainly of snow and glacial melt combined with surface runoff from rainfall. Winter flows are restricted almost entirely to groundwater inflow. Primary water sources for the Maclaren and East and West Fork Susitna Rivers are the numerous glaciers which rim the northern basin divide in the Alaska Range.

The Tyone River contribution is mostly reservoir outflow from the multitude of lakes located within its subbasin. Winter flows begin in early November and are composed of baseflow from subsurface storage. When breakup nears in March and April, subsurface storage is depleted to the extent that many small tributaries cease flowing, and the Susitna River flow shrinks to its seasonal minimum. Following breakup, flows increase rapidly with the onset of spring snowmelt. As summer temperatures increase, glacial flow accentuated by rainfall runoff becomes the predominant river source. The cycle repeats itself with winter freezeup.

The variability of streamflow within the basin is extreme. The following table represents average annual streamflow conditions for portions of the basin above the Gold Creek gaging station.

Flow Variations in Upper Susitna River Basin

Gaging Station	Drainage Area (Sq Mi)	Percent of Gold Creek Drainage Area	Percent of Gold Creek Streamflow
Maclaren River near Paxson	280	4.5	10.0
Susitna River near Denali	950	15.4	27.6
Susitna River near Cantwell	4,140	67.2	64.8
Susitna River at Gold Creek	6,160	100.0	100.0

Nearly 38 percent of the Gold Creek streamflow originates from 20 percent of the area. This large percentage of streamflow is contributed by glaciers in the upper portion of the basin and by high precipitation runoff rates which result from impervious glaciers. In addition, it is suspected that the mountains form a geographic constraint, which causes excessive precipitation in this area in relation to the remainder of the basin.

By contrast, the Cantwell gaging station shows a runoff rate not consistent with that which could be expected below the glaciers, indicating that below the Paxson and Denali stations a large area contributes little annual streamflow. This large, low contributing area is believed to be the flat, 700-square-mile Lake Louise area. Below the Cantwell station, flow percentages increase slightly to a more nearly normal area-discharge relationship for the basin.

GEOLOGY

The geology of the Upper Susitna River Region reflects the complex processes which make up its geologic history. It has undergone subsidence, marine deposition, volcanic intrusion, mountain building, glacial planing, and erosion. In the upper reaches of the river, the valley floor is composed of reworked glacial moraine and lakebed deposits, which are thought to be approximately 200 feet thick. Materials range in size from silt to boulders. Adjacent mountains are composed of metavolcanics and metasediments (lava flows and sediments which have been changed by heat and pressure), and the bedrock beneath the valley floor is also assumed to be a complex of rocks altered from preexisting rock by pressure, heat, and changes in the chemical environment. In the midsection of the Upper Susitna, massive intrusions of granitic rock have warped and uplifted the region. Subsequent vigorous earth movement resulted in the building of the Talkeetna Mountains. Throughout this area the metavolcanics and metasediments are warped and twisted; medium-grained granite intrusives are exposed intermittently along the valley walls. At the lower end of the drainage, glacial action is evidenced by the absence of overburden materials at higher elevations and the scouring and planing of the underlying bedrock.

REGIONAL TECTONICS

Tectonics deals with rock structures and external forms resulting from large movements or deformation of the earth's crust. Two major earth tectonic features bracket the Upper Susitna Region. The Denali Fault, active during Holocene (Recent) time, is one of the earth's major fractures. It lies approximately 43 miles north of the proposed Devil Canyon damsite. A second arcuate fracture, the Castle Mountain Fault, lies some 75 miles to the south of the river basin. Bisecting the region in a northeast-southwest direction and truncated by the Denali

Fault, the Susitna Fault lies approximately 2.5 miles west of the proposed Watana Dam. Large, prominent lineaments pass through the region trending northeast-southwest, and the river valley is controlled by many of these features.

SEISMOLOGY

Since it is located in an area of major faults, it is to be expected that the Upper Susitna Basin would lie in a zone of major seismic activity. During the period of record, through the end of 1970, 262 earthquakes had been recorded within a radius of 150 miles of the proposed Devil Canyon site (Kachadoorian 1974). Of these, 229 had a magnitude on the Richter scale of less than 5.3, while 20 were between 5.3 and 7.0, eleven were between 7.0 and 7.75, and two were greater than 7.75. An evaluation of the potential exposure of the Upper Susitna damsites to seismic activity was made by the Bureau of Reclamation. In view of the recent advances in seismic technology, faults capable of influencing major design features will be reevaluated for their potential Maximum Credible Earthquake.

VEGETATION

Most of the Upper Susitna River Basin is classified as moist or alpine tundra although the area adjacent to the main river channel below the Maclaren River is classified as either upland or lowland spruce-hardwood forest. Major timber species of the canyon slopes and surrounding benchlands are birch, balsam poplar, black cottonwood, white spruce, and black spruce. Overall, timber is of poor quality, varying widely in size, but mostly small and of little or no commercial value. Two distinctly different plant communities occupy portions of the alternate transmission corridors. Bottomland spruce-poplar is confined to the broad flood plains, river terraces, and warm slopes of major rivers. Throughout the lowlands, another distinct vegetation type is low brush-bog/muskeg. Common plants include tamarack, black spruce, alder, willow, and various berries.

FISH AND WILDLIFE

Both resident and anadromous fish inhabit the Susitna Basin. Salmon are known to spawn in many of the sloughs and tributaries of the Susitna River below Devil Canyon; however, surveys indicate that salmon may be unable to ascend the turbulent Devil Canyon and thusly be prevented from migrating into the Upper Susitna River Basin. Grayling, rainbow trout, lake trout, Dolly Varden, whitefish, and burbot comprise the principal resident fish populations.

Mammals and birds found in the Upper Susitna Basin are representative of wildlife species common to interior Alaska. Important game species consist of moose, caribou, and Dall sheep. Wolves, wolverine, bear, and smaller fur bearers inhabit the basin. Birds are predominantly seasonal, and include waterfowl, raptors, and passerine species. The peregrine falcon is the only rare or endangered species presently known to frequent or inhabit the basin.

PRODUCTS OF FEASIBILITY ANALYSIS

The results of studies will be presented in a Project Feasibility Analysis Report supplemented by a series of appendices and a document supplementing the Environmental Impact Statement.

TENTATIVE DOCUMENTS

Project Feasibility Analysis, Main Report

Appendices

- Hydrology
- Power Studies
- Site Selection
- Plan Formulation
- Transmission Facilities
- Access
- Foundations and Materials
- Real Estate
- Design and Cost Estimates
- Marketing Analysis
- Environmental Studies
- Recreation
- Cultural Resources

Environmental Impact Statement (Supplement)

REPORT DESCRIPTIONS

The Project Feasibility Analysis, Main Report will be a summary document presenting the studies and investigations made to reformulate the project to meet present day conditions and to augment the preauthorization feasibility analysis where deficiencies exist. The report will

be primarily a planning document in which plan formulation, impact assessment, and cost estimates will be presented in sufficient detail to support the conclusions and recommendations made. Also the recommended plan will be described, and the economic and financial analyses summarized.

The Hydrology Appendix will document the basic hydrologic information upon which the project analysis will be based. Included will be discussions of daily streamflow, hydrology and climate within the basin and along the transmission corridor, sediment transport, erosion potential, icing, flood routing, and spillway design floods.

The Power Studies Appendix will describe the analysis of energy capabilities of the various plans studied. It will include the results of seasonal and hourly regulation studies to determine the need for a reregulation reservoir. The report will also contain head duration curves, tailwater duration curves, turbine efficiency curves, and suggested operating rule curves.

The purpose of the Site Selection Appendix will be to present the considerations resulting in specific recommendations as to dam types and heights for each site. The report will explain the mechanics of the reviewing process and the rationale for specific site selection on the basis of foundation suitability, quantity, quality, and location of construction materials, and mass-quantities and cost-height relationships.

The Plan Formulation Appendix will document the procedures and rationale by which the recommended plan of development is selected. The procedure will entail identification of planning objectives, the assessment of available alternatives and their impacts, and a comparison of alternatives from the standpoint of economic development and environmental considerations. The selected plan will be that plan which provides the greatest contributions to the study objectives.

The Transmission Facilities Appendix will present the studies involved in selection of transmission line routes, towers, conductor and hardware, substations and switchyards, and other transmission facility components. The selected scheme will be described in detail. Also included will be a transmission line reliability analysis.

The access route alternatives will be outlined and the considerations in route selection presented in the Access Appendix. Vertical and horizontal alignments will be shown, and their advantages and disadvantages in relation to grade, curvature, distance, bridge requirements, and foundations will be evaluated. Particular emphasis will be placed on the requirement for an all-weather access and on the potential winter problems of snow and ice.

The results of exploration, testing, and evaluation for geological and foundation conditions will be presented in the Foundations and Materials Appendix. Documentation will completely define the quality of the dam foundation and the extent and type of foundation treatment required for design. Location and quality of embankment materials will be shown and test results outlined with particular emphasis on strength of materials under high confining pressures and dynamic cyclic loading. Special emphasis will also be placed on regional and site geology and faulting and its relation to the potential seismicity of the area. Seismic studies will be described, including the design earthquake parameters and a dynamic soils response analysis for the embankment.

The Real Estate Appendix will contain information on land ownership and value. The report will include an overall real estate project map along with more detailed segment maps. A gross appraisal will be prepared with supporting narrative to provide technical justification for land costs.

Contained in the Design and Cost Estimate Appendix will be a discussion of dam type and height, foundation conditions, material sources, general configuration of spillway and outlet works, penstocks and powerhouse, intake systems and gates, and any other pertinent dam features. Other project components such as construction facilities and reservoir clearing will also be described. Further, it will contain the various plan cost estimates used as a basis for choosing the selected plan and also the rationale and assumptions underlying the estimates. The investigations and design associated with the first phase of construction will be relatively more detailed than that for subsequent project phases, and the accompanying cost estimates for first phase construction will therefore be more refined and reliable.

The Marketing Analysis Appendix will document the extensive investigations and analyses leading to the load growth forecast and market for Susitna power. In addition it will contain a detailed assessment of existing plant retirement, a discussion of the role of Susitna power in the long-term Railbelt energy supply system, and a financial analysis.

The Environmental Studies Appendix will serve as a reference document for the impact assessment and plan formulation process, as well as for supplementing the Environmental Impact Statement. The report will be a consolidation of the socioeconomic, biological, and water quality data collection and impact identification studies.

Narrative and plates detailing the proposed recreational development, along with the reasoning for its selection will be presented in the Recreation Appendix.

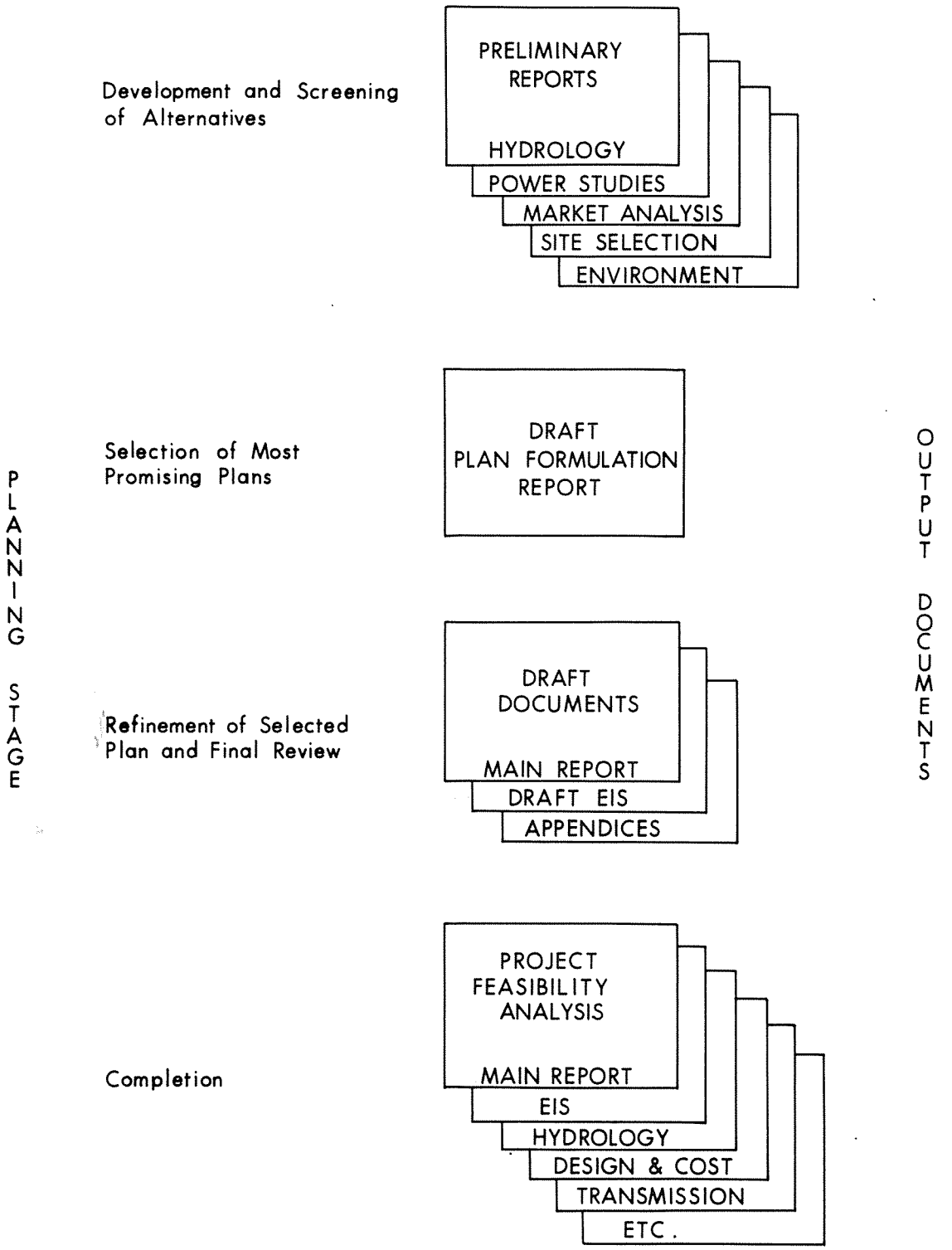
The Cultural Resources Appendix will be a reconnaissance report presenting the findings of both the archeological and historical studies. The appendix will contain information relating to the identification of archeological and historical resources located in the project area and to the probable project impact on those resources.

The Environmental Impact Statement (Supplement) will summarize the full range of environmental, economic, social, and engineering studies. Impacts resulting from the various project features will be discussed and evaluated. The report will be designed to concisely describe the tradeoffs involved among the various schemes of development and to present the rationale for any recommendations made.

DOCUMENT SEQUENCE

Preceding these final documents will be four preliminary appendices covering hydrology, power and marketability, site selection, and environmental studies. These preliminary appendices will serve as a basis for preparation of a draft plan formulation report. Following the choice of the most favorable plans through the plan formulation process, more detailed attention will be directed at formulating the selected plan with results documented in draft appendices. After appropriate review, these will be finalized along with the Project Feasibility Analysis Main Report and the Environmental Impact Statement (Supplement). The sequence of preliminary, draft, and final documents is depicted in Figure 5.

FIGURE 5: PROJECT FEASIBILITY ANALYSIS DOCUMENT SEQUENCE



PUBLIC INVOLVEMENT AND COORDINATION

The objective of public participation is to further involve the public in the project feasibility study, in order to insure that the study responds to public views and preferences to the maximum extent possible. As used here, the term "public" includes other Federal, State, and local government entities and officials; public and private organizations; and individuals interested or potentially interested in the Susitna project.

SUMMARY OF PREVIOUS PUBLIC INVOLVEMENT

In conjunction with the 1976 Corps of Engineers feasibility study, numerous comments were received at public meetings and from written statements on the report findings and reccommendations. Over 65 agencies, organizations, and individuals have provided written comments or oral testimony. In general, comments focused on the need for additional studies before a final decision on construction of a project of such magnitude. The Chief of Engineers has responded to all comments received during review of his draft report and companion Environmental Impact Statement and agreed that additional studies are required before a recommendation can be made for construction. The activities outlined in this plan of study reflect public comments and concerns expressed on the 1976 feasibility report.

Comments of Governor Jay Hammond expressed in his letter of November 17, 1976, to the Chief of Engineers are quoted as follows:

> "I concur in the recommendation by the Board of Engineers report that further study effort is needed for a project of this magnitude. I agree that additional detailed studies, including those addressed by my task force, will be required to determine the significant impacts associated with the magnitude and complexity of the project. Our task force recommendations will be supplied to the District Engineer.

"The information obtained from the District Engineer concerning studies proposed in the next stage coincides well with the environmental, socio-economic and technical studies identified by the State Task Force during review of the Draft Environmental Impact Statement. As these detailed studies are addressed, coordination should be maintained with the State's designee to assure that assessments are answering those points raised in the task force report and to insure that the information developed will be adequate on which to base future State recommendations."

INTERAGENCY COORDINATION

Coordination will be carried out on a continuing basis with Federal, State, and local agencies having interest in the study. Should the planning for Susitna hydropower proceed in the joint State-Federal mode, an extremely close working relationship is envisioned between the Corps of Engineers and the State of Alaska. To ease the coordination problems inherent in a planning program of this magnitude, a single point of contact would be established for the State and a single point for the Corps of Engineers. These would be the Alaska Power Authority on the one hand, and the Alaska District on the other. This State agency would coordinate State reviews of study progress, and formulate feedback into a consolidated State position. The Alaska District would be responsible for and would coordinate all study activities, thus serving as the point of interface between the State and those engaged in accomplishing the project feasibility analysis. Included in this group would be various Corps of Engineers elements, other Federal agencies, private consultants, and State agencies, such as the Department of Fish and Game, that will provide special technical services.

In addition to the ongoing coordination with agencies at all levels of government, there will be an opportunity for formal review and comment after distribution of the draft Project Feasibility Analysis Report and accompanying draft supplemental Environmental Impact Statement. The substance of all comments received will be incorporated in the final report and impact statement supplement.

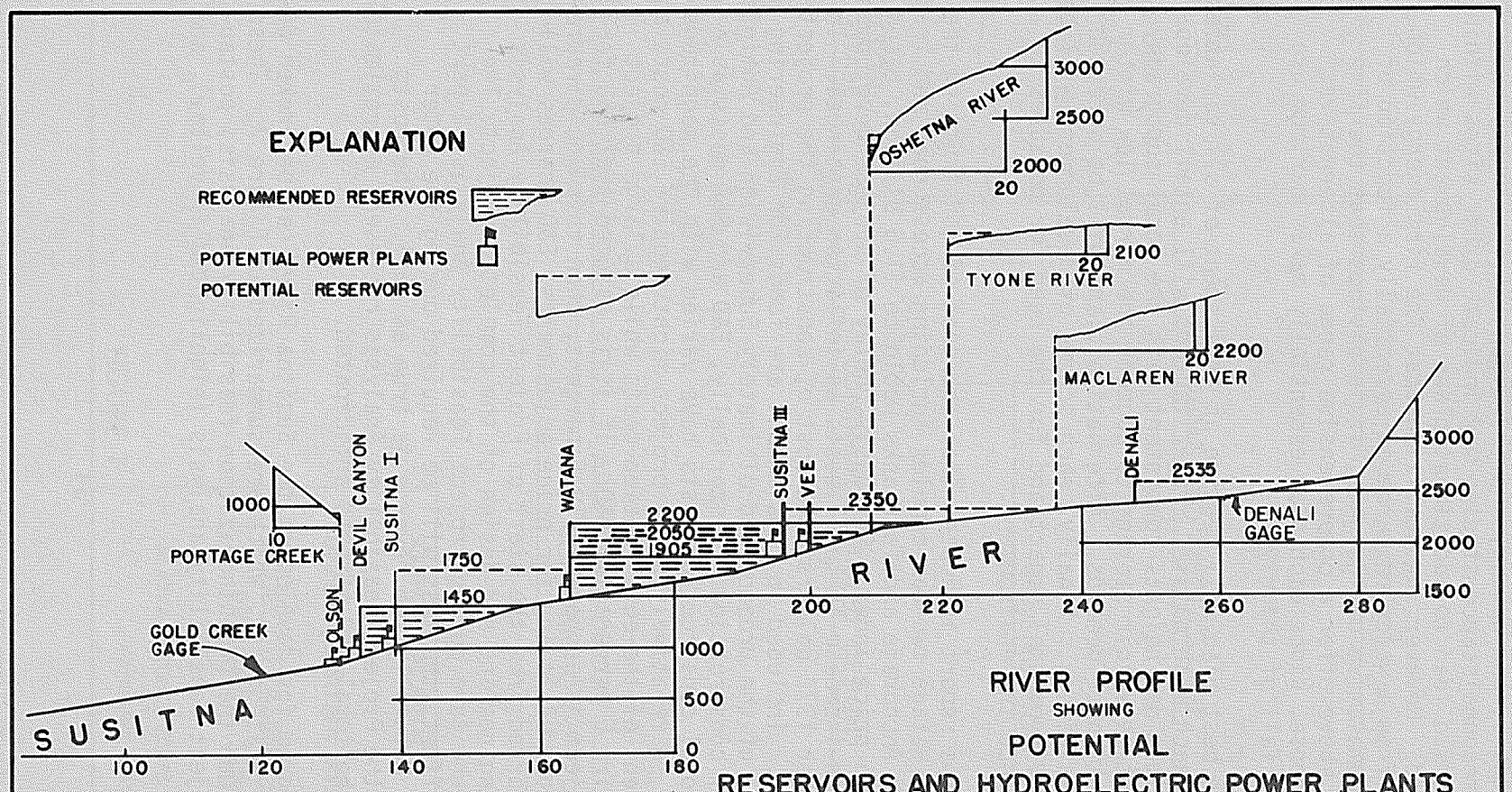
PROGRAM SUMMARY

The activities identified for accomplishment during the Project Feasibility Analysis are those that are considered necessary to establish the feasibility of developing the Upper Susitna hydropower potential; further, they outline sufficient engineering analysis to determine a reasonably accurate cost estimate for the initial features to be built, namely the transmission line, access road, and the first dam. It must be realized, however, that as the planning process evolves and new information becomes available the program must be flexible enough to allow changes in the study direction. The present work program has been based on certain specific assumptions, but the planning process will be capable of responding to what is actually a dynamic situation. In brief, initial efforts will be aimed at determining the optimal basin development; this will lead to a detailed feasibility analysis of the selected plan and then ultimately to specific feature design. Also to be examined, however, will be other basin development schemes which could be analyzed in depth if the exploratory program should uncover some overriding factor which might preclude the development of the plan first selected for detailed analysis.

An important part of the planning will be the early screening of energy alternatives to validate the choice of Susitna hydro as the most favorable alternative for the Railbelt Area. Although the results of this screening are expected to generally conform to the earlier feasibility study, the outcome is not guaranteed. For the purpose of outlining a planning program, it has nonetheless been assumed that further analysis will show hydroelectric development on the Susitna River to be the most favorable course to pursue. Further, it has been assumed for the purpose of detailing the planning program that the two-dam scheme of Watana and Devil Canyon will be the selected plan. This is a reasonable assumption since the preauthorization report upon which the two-dam selection is based is a fairly recent study. Other results from the screening would cause an alteration in the planning program, but the scope of the program outlined for the two-dam scheme is representative of the effort that can be anticipated. The cost associated with foundations and materials exploration and testing is the item most sensitive to departures from the assumed two-dam scheme or to the discovery of unexpected geological conditions. Additional requirements such as expanded environmental or archeological studies would, of course, increase the program costs.

Considering the limited number of damsites available within the Upper Susitna River Basin, the task of determining the best plan of development should be relatively straightforward. Much work has already been accomplished by the Corps of Engineers and Bureau of Reclamation in amassing baseline data upon which a sound decision can be made concerning basin development. Within the past two decades the Bureau of Reclamation has conducted a reconnaissance-level foundation exploratory program for the Devil Canyon, Vee, and Denali damsites. To this the Corps of Engineers has added a seismic refraction analysis of the Watana damsite, surfacial mapping of the basin using conventional aerial photography and ERTS imagery, and an environmental and esthetic assessment of the entire basin. Streamflow and sediment transport data has been collected by the U.S. Geological Survey, snow accumulation data has been collected by the Soil Conservation Service, and some meteorological data has been provided by the U.S. Weather Service. Also, preliminary wildlife inventories were provided through U.S. Fish and Wildlife Service. This data, along with economic evaluations by the Corps of Engineers and marketing and transmission line analysis by the Alaska Power Administration, served as the primary input to the 1976 preauthorization feasibility study on Susitna hydropower development conducted by the Corps of Engineers. During that study a number of alternative basin developments were analyzed, with the conclusion that the best plan of development would consist of Devil Canyon and high Watana as described under Project Description.

Subsequent review of geotechnical data provided by the Bureau of Reclamation has led the Corps to conclude further that, given the present state-of-the-art of large dam construction, the Denali damsite, being underlain by discontinuous permafrost and deep glacial deposits, is not a desirable site for development. Somewhat similar conditions at the left abutment of the Vee damsite make that site questionable for development as well. Early in the proposed Project Feasibility Analysis, therefore, it is anticipated that at least the Denali damsite would be definitively eliminated from consideration for development. Consequently, the only viable damsites available would be those located along a 63-mile stretch of the river between the downstream terminus of Devil Canyon gorge near Portage Creek to the Vee damsite at Vee Canyon. Within this stretch of river there have been 6 sites identified for possible development. They are: Olson, Devil Canyon, Susitna I, Watana, Susitna III, and Vee. The location of these projects within the basin is shown on Figure 6. Based on these sites a number of possible schemes for full basin development are available depending, of course, on the height of each dam in relation to the others. Combinations of dams which have been identified for possibile development, irrespective of economic or environmental feasibility, are: (1) Devil Canyon and Watana; (2) Devil Canyon, Watana, and Vee; (3) Olson, Susitna I, and Susitna III or Vee depending on the availability of a damsite at Susitna III;



RIVER PROFILE
SHOWING
POTENTIAL
RESERVOIRS AND HYDROELECTRIC POWER PLANTS

ALL DISTANCES SHOWN ARE IN MILES FROM THE MOUTH AT COOK INLET.
ALL ELEVATION ARE IN FEET AND REFER TO MEAN SEA LEVEL DATUM.

SOUTHCENTRAL RAILBELT AREA, ALASKA
ALASKA DISTRICT, CORPS OF ENGINEERS
FIGURE 6

(4) Olson, Susitna I, and Watana; and (5) Olson, Devil Canyon, and Watana. Early reconnaissance studies may indicate other sites within the basin that could lead to additional plans of development which should be studied. However, by realizing that the firm energy which can be obtained from a water resource is essentially a function of streamflow and cumulative dam heights, it is obvious that the five plans mentioned above offer a comprehensive range of alternatives from which to choose, since each plan essentially makes maximum use of the available fall of the river.

Selection of the best plan will require an assessment of all variables associated with each alternative. Power factors will entail development of the maximum dam heights consistent with the local topography and of sufficient reservoir storage to augment the normal low winter flow to meet peak power demands. Alternative plans will be screened for economic feasibility. Finally, each scheme of development will be evaluated for environmental impact and for the need for measures to preserve or enhance the environment.

The previous Corps report indicated that the cost of constructing the Devil Canyon and Watana two-dam complex including access road and transmission lines to Anchorage and Fairbanks would be $1.5 billion, based on a January 1975 price index. Obviously, delay of project development will result in an increase in total costs as inflation continues. In fact, in September 1977 dollars, the cost of constructing the project was $2.1 billion. Included in this amount are funds for Engineering and Design (E&D) of the project and ultimately Supervision and Administration (S&A) of construction. Historically, E&D and S&A costs as a percentage of total construction costs have varied with the magnitude of the project. A relatively small project might require E&D costs as high as 12 percent of the construction costs while a large project would only require 5 percent for E&D. If it is assumed that E&D for the Susitna project is approximately 5 percent, then this would represent $100 million. Allowing for price adjustments, E&D charges will cover costs incurred from the start of Project Feasibility Analysis through final engineering and design of the completed project. The greater the expenditure during Project Feasibility Analysis, a part of the design effort, the less will be required during the later design phases. Naturally the reverse is true as well. The costs identified for the Project Feasibility Analysis represent approximately 25 percent of the total E&D efforts anticipated.

The overall program for developing the Susitna River can be broken down into three major categories, which are summarized in Figure 7. These categories include the preauthorization feasibility analysis, postauthorization project feasibility analysis (highlighted in yellow), and

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CONGRESSIONAL DELIBERATION

STATE OF ALASKA FUNDS PLAN OF STUDY

PRECONSTRUCTION STUDIES AUTHORIZED UNDER SECTIONS 160 AND 203

CHIEF ENGINEERS COMMENDS ONSTRUCTION STUDIES

STUDIES

PLAN OF STUDY

BASELINE DATA ACQUISITION

CONTINUED DATA ACQUISITION

DETAILED FEASIBILITY ANALYSIS

(STEP 2)

PLANS AND SPECIFICATION

SHOULD PROJECT BE CONSTRUCTED ?

CONSTRUCTION

PRELIMINARY SCREENING

(STEP 1)

ARE DETAILED STUDIES WARRANTED ?

DETAILED DESIGN FOR INITIAL PHASE

(STEP 3)

CONTINUED DETAILED DESIGN

WHAT IS THE COST OF INITIAL PHASE ?

PROJECT FEASIBILITY ANALYSIS

ADDITIONAL DESIGN AND CONSTRUCTION

ACTIVITY:

SURVEY, EXPLORATION, BIOLOGICAL STUDIES, SEISMIC MONITORING)

ITAL ASSESSMENT

SOUTHCENTRAL RAILBELT AREA, ALASKA

UPPER SUSITNA RIVER BASIN

PROJECT FEASIBILITY ANALYSIS PROGRAM SUMMARY

ALASKA DISTRICT, CORPS OF ENGINEERS

ANCHORAGE, ALASKA

FIGURE 7

BASELINE DATA ACQUISITION

ENVIRONMENTAL IMPACT STATEMENT

PREAUTHORIZATION FEASIBILITY ANALYSIS

CONGRESSIONAL DELIBERATION

REVIEW

CHIEF OF ENGINEERS RECOMMENDS PRECONSTRUCTION STUDIES

STATE OF ALASKA FUNDS PLAN OF STUDY

PRECONSTRUCTION STUDIES AUTHORIZED UNDER SECTIONS 160 AND 203

PREAUTHORIZATION STUDIES

PLAN OF STUDY

BASELINE DATA ACQUISITION

DETAILED FEASIBILITY ANALYSIS

(STEP 2)

PRELIMINARY SCREENING

(STEP 1)

ARE DETAILED STUDIES WARRANTED ?

PROJECT FEASIBILITY ANALYSIS

COLORS CORRESPOND TO TYPE ACTIVITY:

- FIELD WORK (SURVEY, EXPLORATION, BIOLOGICAL STUDIES, SEISMIC MONITORING)
- DESIGN
- PLANNING
- ENVIRONMENTAL ASSESSMENT

finally, project construction. As can be seen from the diagram, completion of the plan of study brings the project to the threshold of the project feasibility analysis. The preauthorization report was initiated in January 1975 and was completed by the Alaska District Corps of Engineers in December 1975. Funds expended on the project by the Corps and other State and Federal agencies represent approximately $1 million for the preauthorization report. This includes the Feasibility Report, Technical Appendices, and Environmental Impact Statement. Subsequently the report and final Environmental Impact Statement was submitted to the President's Office of Management and Budget (OMB) in the summer of 1977 for their review and comment prior to transmitting the report to Congress. In September the Office of Management and Budget notified the Corps of the need to update the benefit-to-cost status prior to their recommending release to Congress. It was agreed that the Corps could conduct a supplemental feasibility update study that would primarily increase the geological data available to confirm assumptions made in developing the project cost estimates. The activity is being funded by reallocating $3 million of Corps study funds and is to be complete by January 1979.

Once again, considerable effort had been expended in previous years by the Bureau of Reclamation for geotechnical exploration, and by other State and Federal groups, for which there is no estimate of expenditures. The preauthorization study entailed a review of energy alternatives available to meet intermediate power requirements, a screening of these alternatives, and an assessment of effects for the more feasible alternatives. A number of development schemes for the Upper Susitna were analyzed, and at least three were found to be economically feasible. As an alternative to Susitna hydropower, coal was found to be the most likely future energy source for both Anchorage and Fairbanks although it would be 30 percent more expensive than Susitna power. The study established with reasonable certainty that economic feasibility of Susitna hydropower development exists, and that there are no adverse environmental impacts of such magnitude that the project should not be considered further.

Obviously, during these early studies a number of questions were raised which remain to be evaluated in more detail during the next level of analysis. Some of the major questions relate to the exposure of the dams to high seismic activity, to inflow of sediment to the reservoirs, to the validity of power projections, to the possibility of induced economic and population growth, to possible construction cost overruns, and to the possible impact on downstream fisheries. On the basis of the information contained in the preauthorization report, Congress authorized the Corps of Engineers to conduct preconstruction planning in a joint program with the State. Subsequently, on 30 June 1977 the State made funds available to the Corps to develop this Plan of Study for accomplishment of the Project Feasibility Analysis.

The activities identified in this plan of study for accomplishment during the Project Feasibility Analysis have a total estimated cost of $24.1 million over a time frame of 46 months. The cost estimate, which is based on a September 1977 price level, is a compilation of costs for performing 202 distinct activities as described in the following section, Description of Program Activities. It can be expected that cost escalation will have its effect upon the September 1977 estimates, also that cost adjustments will be necessary for individual activities as further site information is developed during the planning and design process. However, there should be a balancing effect of these adjustments within the total estimated cost. As shown on Figure 7, the Project Feasibility Analysis has been broken down into three specific steps, with each step leading to a decision as to whether or not the project should proceed based on the accumulation and analysis of a continually growing data base. These three decision points, to be reviewed periodically, will provide assurance that a mechanism exists for review of technical, environmental, and economic information in light of possible changing needs and State policies. In a manner similar to the process by which the 1976 Feasibility Report served as the basis for proceeding to the upcoming planning stage, each decision point will indicate whether or not the project remains feasible and planning should continue. The three progressive steps which make up the Project Feasibility Analysis are: (1) preliminary screening, (2) detailed feasibility studies for the selected plan of development, and (3) detailed design studies for the access road, transmission system, and first project to be built, presumably Watana. If at the conclusion of any of these decision points the project is found to lack economic or environmental justification, this, with sufficient funds for demobilization, would serve to terminate the planning process. It would further serve as the basis for assumption by the Federal Government of all costs incurred during the Project Feasibility Analysis as provided for under Section 203 of the 1976 Water Resources Development Act.

As with any large development project, the expenditure of funds is made with a degree of uncertainty that they will provide future benefits. This is indeed the case with the Project Feasibility Analysis in which some activities do not contribute directly to the planning step within which they are scheduled, but are essential for timely input to one of the later planning steps. For instance, water quality data collection may not be necessary for the initial screening step, but if sufficient data is going to be available for detailed feasibility studies and detailed design, this activity must be started at the outset of the planning program. This process is already taking place, as the U.S. Fish and Wildlife Service has been provided FY-77 funds to continue certain fish and wildlife studies for the Susitna project that could not, by their nature, be meaningful unless conducted for a period of several years duration. This is true of many other studies as well. If indeed the Susitna project proves to be more feasible than other

energy alternatives, it is economically advantageous to bring it on line as early as possible. Thus, to preclude a protracted planning period, there is a certain amount of necessary overlap among the three steps.

Step 1, Preliminary Screening: This step will begin with public meetings, a review of previous reports and an update of preliminary evaluation criteria used for judging the alternatives. Those alternative energy sources which obviously fail to fulfill the evaluation criteria will be dropped from consideration. Specific to Susitna development, a number of potential damsites and combinations of different dams and heights will be evaluated to identify the most economical and environmentally acceptable plan based on preliminary assessments and calculations of benefits and costs. During this study phase, the best plan identified in the 1976 feasibility report, initial construction of Watana, followed by construction of Devil Canyon, will be reexamined. Hydropower analyses will require seasonal reservoir operation studies for each plan of development. Comparative economic analyses will require updated marketing assumptions and reconnaissance-grade cost estimates for each scheme to be analyzed. Additional data requirements over that provided in the 1976 report would include sufficient site reconnaissance of the Olson, Susitna I, and Susitna III damsites to establish a greater reliability in project design features and construction cost estimates. This step will also require a determination of the intermediate and long-term energy source that would be developed if Susitna hydropower were not constructed. The economic and environmental comparison between this nonhydro alternative and each of the hydro schemes will serve as the basis for proceeding with further studies. In addition to serving as an early point of decision regarding additional planning, the preliminary screening will produce a ranking of the various Susitna plans of development from which any recommended plan of development would be selected. This first step is estimated to cost $4.3 million and be completed in 7 months. In order to meet the overall study schedule of 46 months, field work needed in later phases of the study has been scheduled concurrently with the preliminary screening, and these costs have been included in the subtotal of $4.3 million. Some of these major concurrent activities are: (1) installation and operation of additional stream gages, (2) initiation of a hydrometeorological data collection network throughout the basin, (3) detailed mapping and surveying, (4) installation and operation of a field camp at Watana, (5) initiation and continuation of environmental inventories and studies, (6) inventory of possible cultural resources, (7) continuation of the foundation core drilling program at Watana, and (8) seismicity studies and seismic monitoring. It will also be necessary to initiate during preliminary screening some of the in-depth marketing studies that will be used in the later detailed feasibility analysis.

Step 2, Detailed Feasibility Studies: Detailed studies will be concentrated on the best plan identified during preliminary screening.

This assessment will be made using the detailed information and data obtained from the marketing, environmental, hydrological, and foundation studies. The marketing studies will entail refined cost estimates based on expanded information available from the exploratory field program. Project benefits will be determined from the power studies and production cost analysis for the selected plan and viable thermal alternatives. The marketing analysis will include studies that will serve as the basis for forecasting future development, employment and population growth, for assessing the existing and planned generation needed prior to Susitna development, and for estimating future electrical energy requirements and the seasonal distribution of the demand. The marketing analysis will also assess the long-term power system requirements, evaluate retirement of existing and planned power plants, evaluate alternative power sources, and determine financial feasibility. Power studies will primarily be aimed at refining the operation of the two-dam plan, determining the need for long-range peaking generation, and consequently, the need for a reregulation dam. While these studies will be based on full basin development, it must be realized that construction of each phase is dependent on energy demand. Consequently, while construction of Watana is presently envisioned to be followed in 5 years by construction of Devil Canyon, realization of actual energy growth rates may indicate that the second project construction should either be delayed or accelerated. This determination, however, will be made on the basis of future marketing analysis to be conducted concurrently with construction of the first project.

The majority of the biological studies which are either a continuation of existing studies or are those initiated at the outset of this feasibility analysis will be completed during the second step and will be used to assist in determining project feasibility. Some of the biological studies will require continuation through step 3 into construction to provide a base of life cycle habitat and other biological information needed to outline possible mitigation studies. The biological studies outlined in the Plan of Study are of sufficient depth to provide, at the end of step 2, a strong indication of the probable magnitude of impacts of the project and to evaluate project feasibility, but may be unable to define the magnitude of mitigation. Funds for studies beyond step 2 are not provided for in the cost estimate contained herein for the Project Feasibility Analysis Report. The Federal and State Governments recognize that there is a need for funds to maintain continuity of such studies through step 3 and beyond. If the feasibility analysis is favorable and the State decides to pursue construction jointly with the Federal Government, the Alaska Power Authority should develop a source of funding to permit continuation of the biological studies until such time as funding and authority to initiate advanced design and construction has been determined.

Environmental water quality studies will be conducted in concert and simultaneously with biological studies to provide information on water quality parameters. A portion of the hydrological studies will supplement the environmental water quality studies while the majority of the studies will provide input to the power studies and detail design.

A major portion of the exploratory program relating to foundations and construction materials will be accomplished during this phase. Regional and site-specific geologic mapping, initiated under step one, will be completed, and faulting will be defined. A seismic monitoring system will be installed, and the detailed seismic studies required for later definition of earthquake parameters and dynamic soils response analyses will be completed. An extensive drilling program will be conducted at Watana damsite to define and examine foundations and construction material sources; the voluminous drill logs and test results will be catalogued and organized for presentation. The analyses of the Watana site will also include geophysical investigations, concrete studies and sufficient feature design for embankments, cofferdams, powerhouse, spillway, and related features to permit the preparation of the necessary cost estimates. A limited amount of drilling and exploratory tunneling, as well as in-situ rock testing will be completed at Devil Canyon site, and the necessary mapping exploration and testing for the access road and transmission route will be initiated.

This second step is estimated to cost $16.7 million and be completed 25 months after completion of step one. As indicated above, additional field work would continue during this phase of the study, and these costs have been included in the subtotal of $16.7 million. Also included are concurrent activities required for detailed design studies. These design studies would begin during month 20 of the total 46 month period and would be necessary for deriving timely design and detailed cost estimates. Completion of the detailed feasibility report will provide a firm basis for recommending for or against construction of the project, whether Federally funded, State supported under Section 203, or independently financed by the State of Alaska.

Step 3, Detailed Design Studies: The last step would be detailed design of the initial dam and powerhouse, access roads, and approximately 350 miles of double-tower, three-phase transmission line and substations to deliver power to the Anchorage and Fairbanks load centers. Completion of this step would fulfill roughly 80 percent of the foundation exploration program at Watana and 50 percent of the Watana design. Most of the Devil Canyon exploratory and design program would be deferred pending a firm decision to proceed with that phase of the project. The level of design will be sufficiently detailed to permit a reasonably accurate initial project cost estimate enabling a decision on funding and initiating construction. The third step is estimated to cost $3.1 million and be completed in an additional time frame of 14

months after completion of step 2. This phase of the study process will also include the final writing of the Environmental Impact Statement Supplement, the Main Report, and the Technical Appendices.

While the three steps mentioned above provide a broad concept of the general planning process, a more detailed schedule is necessary for plan implementation. For this purpose, the activities identified in the following section have been integrated into such a schedule based on the duration and interdependence of the specific activities. This Critical Path Method (CPM) schedule is shown in Figure 9, found at the end of the report. The termination of the three planning steps are identified in the CPM as nodes 500, 672, and 1060 respectively. Again, it should be emphasized that the program is an evolving planning process, and the schedule will have to be adapted to study findings as they emerge. Further, the schedule is based on a certain assumed assignment of personnel and equipment. Reallocation of resources among the activities may become advisable as the program progresses; this would cause activity durations to change and the schedule to be modified accordingly.

Successful accomplishment of the Project Feasibility Analysis is dependent on timely funding. The CPM activities have been scheduled taking seasonal constraints into consideration with the start date assumed to be the first of May. Realization of this schedule, however, would require early indication of program initiation as well as some limited mobilization funds during the immediate months preceding the program start. This would allow the initiation of the various supply and Architectural-Engineering contracts prior to start of the field season and would allow arrangements to be made for access to the sites. Obviously, if funds became available at some time other than the assumed 1 May start date, the program schedule would necessarily need to be adjusted. With funds provided as assumed, 20 percent of the total cost is required during preliminary screening, 65 percent during the detailed feasibility analysis and 15 percent during the detailed design phase. Accumulated expenditures needed over the study period are shown on Figure 8. A summary of expenditures by year indicates the following estimated funding requirements:

Annual Funding Requirements

Months	Program Funds
1 through 12	$6,766,000
13 through 24	8,856,000
25 through 36	7,880,000
37 through 46	590,000
TOTAL	$24,092,000

The CPM schedule illustrates the accelerated but thorough nature of the project feasibility analysis, with numerous activities being started immediately upon initiation of the program. This approach insures that three summer field seasons will be available for those activities where on-site exploration and surveys are required. Several paths through the activity network are critical or near critical from the standpoint of timing. Delay of any activities along these paths will result in delay of the completion of the program. Relatively more intensive supervision should therefore be directed at these critical activities to insure that schedules are met.

Based on the preliminary schedule presented, the time frame for accomplishment of the various activities appears as Table 1 beginning on page 293.

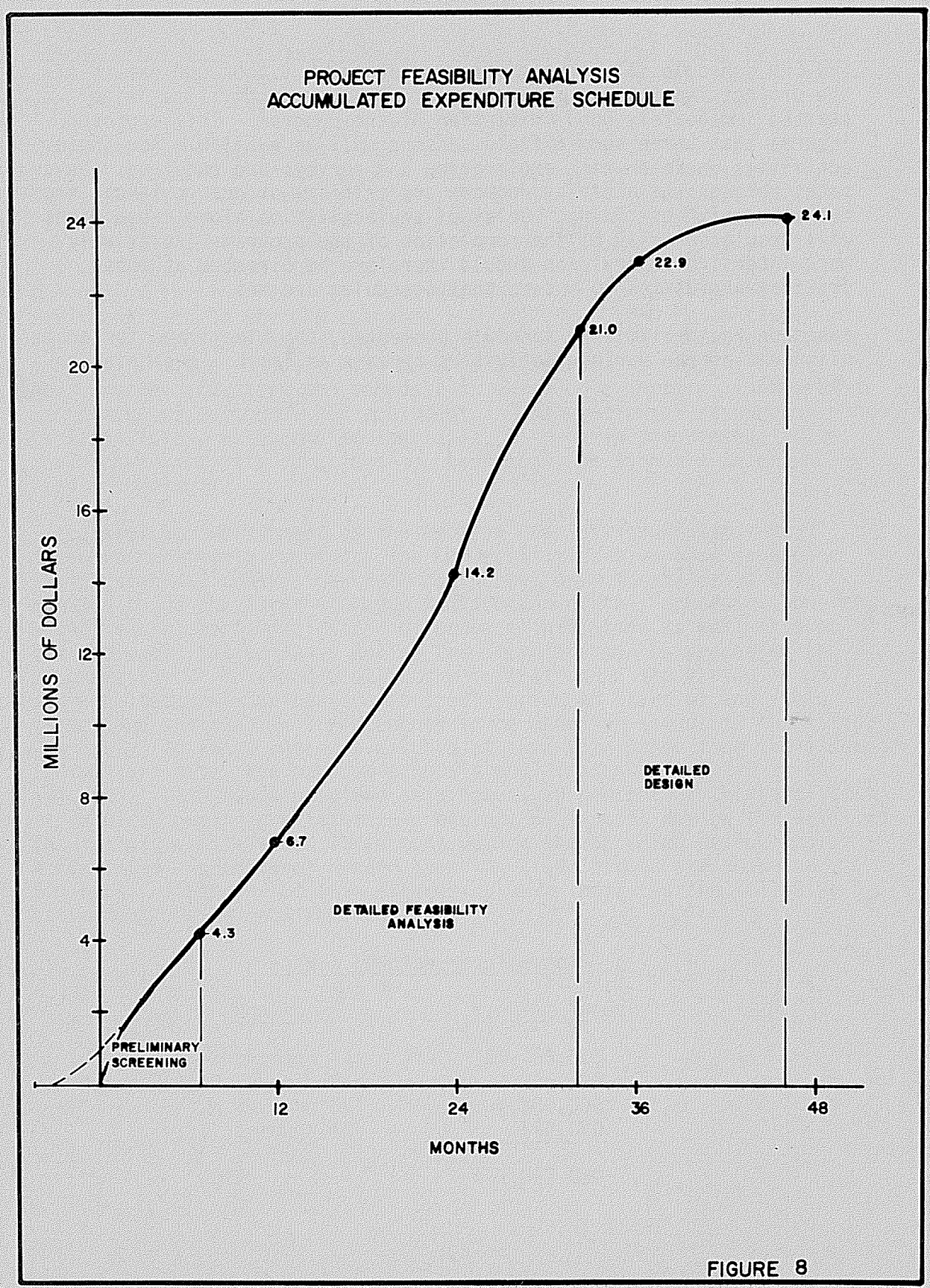

PROJECT FEASIBILITY ANALYSIS
ACCUMULATED EXPENDITURE SCHEDULE
MILLIONS OF DOLLARS
24
20
16
12
8
4
4.3
6.7
14.2
21.0
22.9
24.1
PRELIMINARY SCREENING
DETAILED FEASIBILITY ANALYSIS
DETAILED DESIGN
12
24
36
48
MONTHS

FIGURE 8

DESCRIPTION OF PROGRAM ACTIVITIES

This section contains descriptive summaries and cost estimates for each of some 201 separate activities grouped into 14 major categories. These activities and costs include all items required for the preliminary screening, for the detailed feasibility studies, and for the detailed design activities associated with the initial dam and powerhouse along with transmission lines and access road. A listing of the major categories and cost subtotals follows:

CATEGORY	ACTIVITIES	ESTIMATED COST (in $1000)
Survey	SY-1 thru SY-7	$ 1,180
Hydrology	HY-1 thru HY-27	1,295
Environmental Water Quality	EN-1 thru EN-4	330
Economic Studies	EC-1 thru EC-7	84
Recreation	R-1 thru R-4	56
Plan Formulation	PF-1 thru PF-15	124
Power Studies	PS-1 thru PS-4	198
Power Market Studies	PM-1 thru PM-13	547
Foundations and Materials	FM-1 thru FM-26	9,770
Design	D-1 thru D-39	4,001
Real Estate	RE-1 thru RE-5	59
Cultural Resources	C-1 thru C-2	110
Field Camp	FC-1 thru FC-2	1,625
Biological Studies	B-1 thru B-21	4,263
Reports, Reviews, and Public Participation	RRP-1 thru RRP-26	450
TOTAL COST		$24,092

SURVEY (SY)

THESE ACTIVITIES INCLUDE THE BASIC FIELD WORK REQUIRED TO PROVIDE TOPOGRAPHIC DATA AND RIVER HYDROGRAPHIC DATA NECESSARY FOR DETAILED DESIGN AND COST ESTIMATES, ENVIRONMENTAL ASSESSMENTS, AND HYDROLOGY AND POWER STUDIES. ALSO, THE TOPOGRAPHIC DATA WILL BE UTILIZED IN PREPARATION OF REAL ESTATE OWNERSHIP MAPS.

RIVER CROSS SECTION

1. Obtain river cross sections at preliminary sites.
2. Obtain river cross sections downstream.

MAPPING

3. Map potential reservoir sites.
4. Obtain controlled photo/topo along access route.
5. Obtain controlled photo/topo along transmission corridor.
6. Obtain controlled photo/topo at Watana damsite.
7. Obtain controlled photo/topo at Devil Canyon.

SURVEY

Activity Designation: SY-1

Activity: Obtain river cross sections at preliminary sites.

Description: This activity is to obtain river cross sections at the following sites: one each at Olson, Devil Canyon, Susitna I, Susitna III, and Vee; and three at Watana. Cross sections at Watana will be located at centerline, 1/2 mile upstream, and 1/2 mile downstream. The remainder of valley topography will come from SY-3 and will be required in the first 6 months. Field parties will obtain data necessary to determine cross sections by taking a series of soundings across the river.

Seasonal Constraint: Winter preferable

Cost: $50,000

SURVEY

Activity Designation: SY-2

Activity: Obtain river cross sections downstream.

Description: The purpose of this study is to obtain an estimated 70 river cross sections from the vicinity of the Olson damsite downstream to highway bridge #3 below Talkeetna. This activity will be in support of activities D-38, HY-21 and HY-16. These activities will be used to study the effects of various flow releases associated with the hourly power studies. The study will also provide information on tailwater rating curves and on the delineation of post-project flood plains.

Seasonal Constraint: June through October

Cost: $300,000

SURVEY

Activity Designation: SY-3

Activity: Map potential reservoir sites.

Description: This activity will entail mapping of potential reservoir sites within the Upper Susitna River Basin. Mapping should be of sufficient detail (20-foot contours) to allow determination of elevation-versus-capacity curves and elevation-versus-area curves for each reservoir. The reservoirs will include the sites of Olson (river bottom to elevation 1,100) Devil Canyon (river bottom to elevation 1,490), High Devil Canyon (river bottom to elevation 1,800), Watana (river bottom to elevation 2,260), and Vee (river bottom to elevation 2,360).

Seasonal Constraint: May through October

Cost: $460,000

SURVEY

Activity Designation: SY-4

Activity: Obtain controlled photo/topo along access route.

Description: This activity is mapping of two road access routes in order to determine design layout. Mapping requirement is for 5-foot contours with a scale of 1-inch equal to 200 feet. The areas to be flown will require photo/mapping an area sufficiently large to support the capabilities of expanding the mapping for alignment revisions.

Seasonal Constraint: May through October

Cost: $225,000

SURVEY

Activity Designation: SY-5

Activity: Controlled photo/topo along transmission corridor.

Description: This activity is for providing topographic maps, based on existing U.S. Coast and Geodetic Survey quads prepared as overlay to aerial photography mosaic. Aerial photography will be obtained at a scale of 1 inch to a mile for preparing mosaic.

Seasonal Constraint: May through September for photography

Cost: $70,000

SURVEY

Activity Designation: SY-6

Activity: Obtain controlled photo/topo at Watana damsite.

Description: This activity will entail providing survey control and manuscript mapping at the proposed damsite. Requirements for the mapping will be to place picture point aerial photography targets, establish the horizontal and vertical control, obtain aerial photography and accomplish the required mapping. Mapping contours for this activity will be based on 5-foot contour with a mapping scale of 1 inch equaling 200 feet.

Seasonal Constraint: May through October

Cost: $15,000

SURVEY

Activity Designation: SY-7

Activity: Controlled photo/topo at Devil Canyon.

Description: This activity will entail providing survey control and manuscript mapping at the proposed damsite. Requirements for the mapping will be to place picture point aerial photography targets, establish the horizontal and vertical control, obtain aerial photography and accomplish the required mapping. Mapping contours for this activity will be based on 5-foot contour with a mapping scale of 1 inch equaling 200 feet. This mapping will augment topographic data already available.

Seasonal Constraint: Field efforts, May through October

Cost: $60,000

HYDROLOGY (HY)

THESE ACTIVITIES INCLUDE BOTH FIELD WORK AND ANALYSIS. THE COLLECTION OF DATA ALLOWS A DEFINITIVE DESCRIPTION OF THE HYDROLOGY AND CLIMATE OF THE RIVER BASIN AND ALONG THE TRANSMISSION CORRIDOR. OTHER STUDIES, USING THE EXPANDED INFORMATION BASE, EXAMINE STREAMFLOW VOLUMES AND FREQUENCIES, WATER QUALITY, ICE FORMATION, AND THE TRANSPORT, ENTRAPMENT, AND DEPOSITION OF SEDIMENT. EMPHASIS IS PLACED ON COMPARING THE PRE- AND POST-PROJECT CHARACTERISTICS FOR THE PURPOSE OF DETERMINING PROJECT EFFECTS. THE HYDROLOGY STUDIES ALSO SUPPORT THE ENTIRE RANGE OF DESIGN ACTIVITIES.

IMPLEMENT A DATA COLLECTION PROGRAM.

1. Collect climatologic data for basin and transmission line.
2. Install and operate additional stream gages and continue stream gaging.
3. Collect water data.

DESCRIBE HYDROMETEOROLOGICAL SETTING OF BASIN.

4. Describe hydrometeorological setting.

CONDUCT PRE-PROJECT STREAMFLOW ANALYSIS.

5. Extend streamflow and correlate with longest record.
6. Develop annual and seasonal flow duration curves.
7. Develop peak and volume frequency curves.
8. Develop low flow frequency analysis for critical period.

CONDUCT RESERVOIR AND DOWNSTREAM SEDIMENT STUDIES.

9. Determine average annual total load.
10. Determine entrapment rates and reservoir distribution.
11. Determine reservoir suspended sediment stratification.
12. Determine effect on downstream channel.

SPILLWAY DESIGN FLOOD DERIVATION.

13. Obtain final Probable Maximum Precipitation from HMB-NWS.
14. Recalibrate basin model.
15. Determine Probable Maximum Flood and route through reservoir.

WATER SURFACE PROFILE DETERMINATION.

16. Determine water surface profiles from Talkeetna to Watana.

CONDUCT ICE STUDIES.

17. River and reservoir conditions.
18. Review literature about existing storage projects in arctic conditions.

WIND AND ICE STUDIES REQUIRED FOR TRANSMISSION LINE DESIGN.

19. Conduct literature search and limited field survey.

POST PROJECT STREAMFLOW ANALYSIS.

20. Develop post-project frequency curves.
21. Determine post-project downstream water surface profiles.

RESERVOIR FILLING SCHEDULES.

22. Develop reservoir filling schedules.

GLACIAL BALANCE STUDIES.

27. Conduct mass water yield studies.
28. Conduct mass sediment yield studies.

EVAPOTRANSPIRATION STUDIES.

25. Determine evaporation rates.

OTHER ACTIVITIES.

26. Provide preliminary spillway design flood.
27. Determine elevation versus capacity relationships.

HYDROLOGY

Activity Designation: HY-1/1a

Activity: Collect climatological data for the basin and transmission line, and continue data collection.

Description: Inaccessibility of the basin will make conventional data acquisition difficult, and a series of remote data platforms situated throughout the basin is anticipated. Helicopter operations will be necessary to install and operate the data collection platforms. Data acquired will be used for virtually all phases of the hydrology appendix, for supplementing the Environmental Impact Statement, and for design and construction of the transmission line. As a minimum, wind velocity and snow depth and density will be measured at approximately 15 locations along the proposed transmission line corridor. The majority of the anemometer sites will be located in the mountainous areas at the higher elevations along the proposed transmission line route. Appropriate anemometer sites within the Susitna Basin may also be equipped to record temperature, snow depth, and precipitation. Snow creep stations will be developed as necessary where the snow depth and density measurements indicate a potential for snow creep problems along the transmission line. Approximately 10 additional locations in the Upper Susitna Basin will be developed as precipitation, snow depth/temperature stations. Where practical, existing snow courses and stream gaging sites will be equipped to record precipitation, temperature, and other required climatological parameters. It is anticipated that an intensive climatological data-gathering and analysis program will be conducted for two years prior to construction of the project. It would be desirable to continue operating selected climatological stations within the basin after the initial design stage to develop a data base and subsequently provide information to operate the project efficiently. These selected stations should be equipped with telemetry to provide real time data for operation of the project.

Seasonal Constraint: Instrumentation should be accomplished during summer time.

Cost: $423,000

HYDROLOGY

Activity Designation: HY-2/2a

Activity: Install and operate additonal stream gages, and continue stream gaging.

Description: In order to fully evaluate the hydrologic response and variability of flow within the Susitna Basin, an extensive stream gaging network will be required. Existing stations within the Upper Susitna Basin include: Susitna at Gold Creek (U.S.G.S. station number 15-2920-00), Susitna River near Denali (station number 15-2910-00), and Maclaren River near Paxson (station number 15-2912-00). Funding for the operation of these stations should be assumed from the Cooperative Stream Gaging Program, which presently provides the funding. Installation and operation of six additional stream gaging stations would also be required. Gages would be installed on the Tyone River near its mouth, on the Oshetna River near its mouth, on the Susitna River at the former Cantwell gaging station, at the Watana damsite, at the Devil Canyon damsite, and on the Susitna River at the highway No. 3 bridge crossing below Talkeetna. The gages would be installed during the first spring, thus allowing three summers of flow measurement prior to completion of project feasibility analysis. The gages would be converted to permanent status if the projects were authorized for construction. As a result of the number of stations being proposed, correlation with the three existing stream gaging stations should be quite high, thereby allowing streamflow extension to match the existing 27-year period of record for the Susitna River at Gold Creek. The total streamflow record could then be used for reservoir operation studies, suspended sediment and bedload transport analysis, reservoir modeling and selective withdrawal studies, water surface profile determination, and a multitude of other flow quantity analyses.

Seasonal Constraint: Installation required during spring time.

Cost: $300,000

HYDROLOGY

Activity Designation: HY-3/3a

Activity: Collect water data.

Description: Water studies are dependent upon a successful data collection program. Physical sampling will concentrate on suspended sediment and bedload samples to be taken at the stream gaging stations. Frequency of sediment sampling should be sufficient to develop with reasonable accuracy a total load-rating curve to be used in on-going sediment studies.

Seasonal Constraint: None

Cost: $60,000

HYDROLOGY

Activity Designation: HY-4

Activity: Describe the hydrometeorological setting of the basin.

Description: This activity will be used to present and synopsize the hydrometeorological setting of the Upper Susitna River Basin. It will include an evaluation of other descriptions of the area and an interpretation and discussion of the data collected under HY-1 and HY-2. A number of generalized graphs depicting the extremes and averages associated with precipitation, temperature, snowfall, radiation, wind, etc., will be prepared. This information will assist in feature design and in construction activities. It will also provide information to be used in supplementing the Environmental Impact Statement.

Seasonal Constraint: None

Cost: $8,000

HYDROLOGY

Activity Designation: HY-5

Activity: Extend streamflow to match longest historical records.

Description: The purpose of this activity will be to extend the shorter streamflow periods of record of the Denali, Cantwell and Maclaren gages, as well as the six new gages, to match that of the long-term Gold Creek gage. This will provide a good data base for the specific Devil Canyon and Watana damsites and a sufficient indication at other possible damsites for system power studies. Monthly streamflow will be required for seasonal regulation studies; however, daily streamflow would be desirable for impact assessment of the selected plan of development. Streamflow extension would be accomplished by a multiple regression analysis with Gold Creek streamflow and other physiographic and hydrologic parameters. In order to assess the long-term annual water budget of the Upper Susitna Basin, an attempt will be made to correlate annual runoff with other measured physical parameters. The short-term stations will be used to determine the variability of streamflow throughout the basin on a seasonal basis. If strong correlation can be gained with long-term stations, flow duration curves can be developed for the short-term stations which will aid in determining sediment yield throughout the basin.

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-6

Activity: Develop annual and seasonal flow duration curves.

Description: Upon extension of the streamflow records to match those of the long-term station at Gold Creek, seasonal and annual flow duration curves will be developed for all stream gaging stations within the Upper Susitna Basin and major adjacent tributaries. This information will assist in characterizing the variability of streamflow throughout the study area. In addition, it will provide insight into the extent of the groundwater alluvium. This information will be invaluable in describing the environmental setting associated with fish and wildlife studies. In addition, it will provide construction contract information regarding the risk of initiating specific construction activities. Finally, the curves will provide insight about the various sources of flow which constitute the Susitna River and its tributaries.

Seasonal Constraint: None

Cost: $2,000

HYDROLOGY

Activity Designation: HY-7

Activity: Develop peak and volume frequency curves.

Description: Peak and volume frequency curves will be developed for Susitna River at Gold Creek, near Denali, near Cantwell, and for the Maclaren River near Paxson. This will require extension of the three latter stations' periods of record to match that of the Gold Creek streamgage. The frequency curves will be based on an annual series analysis utilizing the Log Pearson Type III distribution with an expected probability adjustment.

Protection of various construction features and diversion tunnels will be based on the results of this study. A determination regarding the level of protection that should be provided during construction will be necessary. This will be based on the anticipated loss to life and property both at the construction site and downstream, which would result without a higher level of protection during construction.

Seasonal Constraint: None

Cost: $2,000

HYDROLOGY

Activity Designation: HY-8

Activity: Develop low flow frequency analysis for critical period streamflow.

Description: The purpose of this activity will be to determine the severity of the low-flow critical period upon which the firm energy and dependable capacity of the recommended plan of river development is based. The analysis will be made after completion of seasonal reservoir regulation studies for the recommended plan. Since pre-authorization reservoir regulation studies have indicated that the critical period may span 32 months or more, it will not be possible to conduct a meaningful low-flow frequency analysis based on the relatively short streamflow period of record (27 years). Thus, the streamflow record will be extended stochastically, followed by an accumulation of critical-period duration flow volumes which will lead to development of a low-flow frequency curve to be created in accordance with procedures similar to those outlined under Chow's Handbook of Hydrology. The frequency curve will indicate the severity of the recommended plan's critical period flow volume. Also developed would be lesser duration volume low-flow frequency curves. Synthetic streamflow will be developed using "HEC-4 Monthly Streamflow Simulation" computer program.

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-9

Activity: Determine average annual total sediment load.

Description: This activity will entail a sediment sampling program which will determine suspended and bed load transport rates for a variety of flows. Also to be obtained would be gradation curves. This would lead to the development of a total sediment rating curve which can then be incorporated into an annual flow duration curve which will provide an estimate of the average annual sediment which will be deposited in the proposed reservoirs. This in turn will indicate the anticipated loss in reservoir storage as a result of sediment entrapment behind the dams.

Seasonal Constraint: Almost all samples will be taken during the summer field seasons.

Cost: $35,000

HYDROLOGY

Activity Designation: HY-10

Activity: Determine sediment entrapment rates and distribution within the reservoirs.

Description: Distribution of sediment within the proposed reservoirs is a function of the reservoir configuration, water temperature, sediment size, variation of inflow, fall velocities and a number of other variables. The distribution of sediment can limit the economic life of a reservoir by encroachment on the usable storage space and on the outlet works. Distribution of this sediment inflow will be calculated using Hydrologic Engineering Center computer program numbers 23-J2-L264 and 723-62-L2470.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-11

Activity: Determine stratification of suspended sediment in reservoir.

Description: While it is anticipated that the reservoirs will entrap 95 percent of the sediment inflow, that which remains in suspension will be released to the downstream channel. Under natural conditions the Susitna River contains heavy sediment concentrations during the summer and minimal concentrations during the winter. Thus, uncontrolled water releases could have the effect of enhancing the summer water quality downstream, but decreasing the winter quality. This study, then, would address the potential for development of sediment stratification zones within the reservoir which conceivably could be flushed during the summer, thus allowing clear releases during the winter. This study would have to be coordinated with temperature and water-quality reservoir modeling studies. Study would incorporate the Waterways Experiment Station "WESTEX" computer model.

Seasonal Constraint: None

Cost: $15,000

HYDROLOGY

Activity Designation: HY-12

Activity: Determine effect of sediment degradation on downsteam channel.

Description: As the natural river sediment is trapped within the reservoirs, the downstream load-carrying capacity of the river will have to be satisfied by sediment lifted from the natural channel. This could result in excessive downstream channel erosion, which could have detrimental environmental effects. Field work for this activity will involve collection of information regarding existing armored areas and potential areas for channel degradation. The study will be conducted using HEC-6, and HEC program #723-G2-L2470.

Seasonal Constraint: This would be a summer operation.

Cost: $20,000

HYDROLOGY

Activity Designation: HY-13

Activity: Obtain final Probable Maximum Precipitation from National Weather Service.

Description: In order to develop the Probable Maximum Flood which will serve as the Spillway Design Flood for the recommended plan of development, it will be necessary to obtain information on Probable Maximum Precipitation, Critical Snow Pack and Critical Temperature Sequence. For the pre-authorization report, tentative values were obtained from the Hydrometeorological Branch of the National Weather Service (HMB-NWS) in Washington, D.C. For the Feasibility Analysis efforts it will be necessary to develop more definitive values in order to refine the Spillway Design Flood derivation. HMB-NWS is normally funded for such activities, and only a nominal charge would be required for coordination. It should be understood, however, that if this project is State funded, the National Weather Service may require reimbursement for the services.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-14

Activity: Recalibrate basin model.

Description: In order to insure that the dams will have spillways of sufficient hydraulic capacity to protect against overtopping, each spillway will be designed to pass a flood which represents the worst possible combination of hydrometeorological events which could reasonably be expected for the Upper Susitna drainage basin. The flood derived from this analysis is termed the Spillway Design Flood (SDF). The SDF will be derived from an analytical model of the river basin. The model is a deterministic computer program which simulates portions of the hydrologic cycle in an attempt to generate long periods of daily or hourly streamflow hydrographs. The model used in the pre-authorization report was the Streamflow Synthesis and Reservoir Regulation (SSARR) program developed by the North Pacific Division, Corps of Engineers. Development of the SDF will be accomplished in two phases. The first will entail model calibration, and the second will be SDF determination. Model calibration will entail reconstitution of historic streamflow hydrographs based on data input obtained from the data collection network outlined under HY-1.

Seasonal Constraint: None

Cost: $25,000

HYDROLOGY

Activity Designation: HY-15

Activity: Determine probable maximum flood and route through reservoir.

Description: Upon calibration of the SSARR basin model, the Probable Maximum Precipitation and other critical weather data obtained from NWS-HWS will be put into the model, for determining the Probable Maximum Flood. A number of scenarios will be used to insure that the most severe flood is obtained. The flood hydrograph for each project will be routed through the respective reservoir based on a number of spillway capacity curves. This will serve as the basis for spillway sizing necessary to maintain an economical and safe freeboard.

Seasonal Constraint: None

Cost: $15,000

HYDROLOGY

Activity Designation: HY-16

Activity: Determine water profiles from Talkeetna to Watana.

Description: This activity will entail a determination of the water surface profile for a variety of flows from below Talkeetna to the vicinity of Watana damsite. In order to accomplish this task, it will be necessary to procure river cross-sections at one mile intervals, and, through the use of the HEC-2 Backwater Curve computer program, develop backwater curves that can be matched against recorded flow at Gold Creek and other gages to be activated.

Seasonal Constraint: None

Cost: $25,000

HYDROLOGY

Activity Designation: HY-17

Activity: River and reservoir ice studies.

Description: Breakup of the headwaters of the reservoirs will result in release of ice which may be expected to pose problems in the upper reaches of the impoundments in the form of jamming, flow blockage, and ice forces. The scope of these problems will be assessed and impact on operations will be evaluated. Field observations of present natural breakup will contribute to an estimate of the extent of the problem.

Operation of a major power plant causes higher discharges during winter months, together with discharge variations. Both of these discharge conditions cause changes in the ice regime of the downstream waters. The purpose of this study is to assess the magnitude of these ice problems to include evaluation of open water reaches, potential production of frazil ice in the open water reaches, potential for flooding and damage due to ice jams, and possible operational and design means to reduce these problems. The study will require mapping of the downstream river reaches, identification of critical sites for ice jamming, inventory of damage-prone structures, and analysis of length of open water as a function of release temperatures and weather. A number of additional ice studies have been identified and should be accomplished prior to final design and construction. The studies identified herein represent those necessary for evaluation of project feasibility and impact assessment. Some of the costs associated with data collection in support of ice studies are included under the three main data collection programs.

Seasonal Constraint: Much data gathering can only be accomplished at specific times during the year.

Cost: $130,000

HYDROLOGY

Activity Designation: HY-18

Activity: Literature survey of existing storage projects in arctic and sub-arctic environments (Ice related studies).

Description: A number of projects in environments as harsh as those in the Susitna Basin have been built in the northern parts of Scandanavia, the Soviet Union, and in the Alps in Switzerland. Technical literature is replete with descriptions of these projects, although not necessarily in English. A compilation of the best of these publications is a necessity in an undertaking of this magnitude.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-19

Activity: Conduct literature search and limited field survey regarding icing considerations in transmission line design.

Description: An investigation into the frequency of occurence and accumulation of rime icing on the transmission line and supporting structures needs to conducted. The study will include a literature review and interviews with climatologists, engineers and maintenance personnel from power companies with transmission lines near the proposed transmission line. The study may also include field investigations.

Seasonal Constraint: Wintertime operation

Cost: $15,000

HYDROLOGY

Activity Designation: HY-20

Activity: Develop post-project frequency curves.

Description: This activity will assist in determining the reduction in flooding downstream from the projects and the associated reduction in flood damage to downstream communities and structures. It will aid in assessing the effect which can be anticipated on the downstream environment. This will be accomplished by integrating daily peak flow events into the seasonal reservoir regulation studies and then developing peak frequency curves in the traditional manner. This will be accomplished only for the recommended plan.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-21

Activity: Determine post-project downstream water profiles.

Description: This study will be conducted in conjunction with post-project frequency curve determinations (HY-20) and hourly simulated operation studies. The major purpose of these studies will be to determine the downstream impact from flow release necessary to meet a variety of power demands, and the river profiles associated with a reduction in peak flows as a result of reservoir regulation. These studies will be accomplished only for the more feasible plans of development. The general method of analysis will entail routing the results of the HY-20 studies to points downstream and then determining backwater curves using the HEC-2 computer program or an unsteady-state model. The more detailed studies will be associated with routing variable flow releases for power purposes. In this case, a series of daily load shapes will be assumed in consonance with a number of downstream flow conditions. The releases will be routed downstream allowing the development of a series of stage hydrographs. The study will indicate the attenuation effect on flow releases as channel storage and tributary inflow begin to predominate. This will indicate the possible need for a re-regulation dam downstream, or possible reregulation from the most downstream power project. These studies would be conducted using the HYSYS computer program and by a finite-difference steady-state flow model.

Seasonal Constraint: None

Cost: $20,000

HYDROLOGY

Activity Designation: HY-22

Activity: Develop reservoir filling schedules.

Description: Because of the seasonal nature of the streamflow within the Upper Susitna Basin, and further, because of the large volume of the Watana reservoir, it would be necessary to establish filling schedules to insure an adequate downstream release in consonance with efficient reservoir filling. The study would entail a reservoir regulation analysis, based on historic streamflow record, in which the reservoir is filled for various downstream flow demand rates under average and critical inflow conditions. An attempt will be made to establish the optimum season that the filling should begin, and the seasonal variability of flow releases necessary for the downstream environment and power demand. Any project developed downstream from Watana would probably not require a similar filling schedule because of its comparatively small reservoir volumes.

Seasonal Constraint: None

Cost: $9,000

HYDROLOGY

Activity Designation: HY-23

Activity: Glacial mass water yield studies.

Description: A large amount of flow of the Upper Susitna River is derived directly from the glacial headwaters in the mountains of the Alaska Range. The water from the glaciers will be advantageous to hydropower in some cases, but possibly detrimental in others. The glacier runoff is guaranteed flow for decades even if drought conditions should occur, because the glaciers are precipitation already in the basin and readily available for runoff each year. On the other hand, glacier outbursts can cause unusual rises in flow at any time of the year. The amount of glacier-derived water and sediment would increase significantly should any of the large glaciers in the basin surge. Both Susitna and West Fork, the two largest glaciers, are surging glaciers and both can be expected to surge within the life of the project.

This activity will consist of establishing reference points on the glacier and measuring water balance and ice dynamics for these specific glaciers. Data will also be gathered on glacial storage and runoff.

Seasonal Constraint: Seasons will constrain some data collection activities.

Cost: $55,000

HYDROLOGY

Activity Designation: HY-24

Activity: Glacial mass sediment yield.

Description: Most of the sediment within the Susitna River originates from the headwater glaciers. Previous studies based on historical data have indicated that this sediment load will have a very minor effect on the project. This is primarily because of the large proposed reservoirs in relation to the estimated average annual sediment load. However, should the glaciers surge, they can impart significantly greater sediment loads than that of the average annual load. Hence, it is necessary to attempt to quantify the magnitude of potential sediment load which could be anticipated should the glaciers surge. Glacier sediment yield could best be measured at stream gaging stations, and it would be best if sediment measuring sites were measured independently. This in consonance with aerial photography should provide sufficient information for definitive estimates.

Seasonal Constraint: Summertime operation for data collection.

Cost: $55,000

Activity Designation: HY-25

Activity: Determine evaporation rates.

Description: Using climatological data from the basin (air temperature, dew point, surface water temperature, wind speed), evaporation rates for the water surfaces can be estimated. Evapotranspiration rates for the land surfaces again can be estimated using climatological data (temperature and dew point have to be measured at at least two levels). These estimated values, which are of great importance as the evaporated water is not available for energy production, can be checked against the difference of precipitation and runoff, which should also give the evaporation rate if ground water movements and storage changes are neglected. Data collection necessary to accomplish the activity is included under activity HY-1

Seasonal Constraint: None

Cost: $10,000

HYDROLOGY

Activity Designation: HY-26

Activity: Provide preliminary spillway design flood.

Description: Prior to project layout for the various hydro schemes that will be analyzed under preliminary sceening, it will be necessary to provide preliminary flood values so that the project spillways can be properly sized for reconnaissance-grade cost estimate purposes. Most of this information can be obtained from the pre-authorization feasibility report; however, new values may be needed for some of the projects not prevously analyzed in depth.

Seasonal Constraint: None

Cost: $1,000

HYDROLOGY

Activity Designation: HY-27

Activity: Develop elevation versus capacity curves.

Description: Based on the 20-foot contour maps, this activity will entail measuring the volume and area of the various reservoirs to be studied during preliminary screening and later during detailed feasibility analysis. This information will be used in the reservoir regulation studies and in the impact assessment.

Seasonal Constraint: None

Cost: $8,000

ENVIRONMENTAL (EN)

THESE ACTIVITIES INCLUDE BOTH FIELD WORK AND ANALYSIS. THE COLLECTION OF DATA WILL ALLOW FOR A DEFINITIVE DESCRIPTION OF WATER QUALITY.

WATER QUALITY STUDIES

1. Collect chemical and biological water quality data.
2. Reservoir temperature stratifation studies and water quality modeling.
3. Analyze spillway and outlet works for dissolved gas production.
4. Assess erosion potential in active storage zone.

ENVIRONMENTAL

Activity Designation: EN-1/1a

Activity: Collect chemical and biological water quality data.

Description: Water quality studies are dependent upon a successful data collection program. Water quality data parameters should initially be sampled a minimum of once every 2 or 3 days. The sampling frequency can be lengthened if the initial sampling demonstrates that there is little change with time and discharge. Some parameters could be measured with remote monitors. Water quality data to be monitored would be dissolved oxygen, B.O.D., C.O.D., pH, phosphorous, nitrogen, nitrate, and specific conductance.

Seasonal Constraint: None

Cost: $140,000

ENVIRONMENTAL

Activity Designation: EN-2/2a

Activity: Reservoir temperature stratification studies.
Reservoir water quality modeling.

Description: These studies would lead primarily to the design of the multi-level power intake structures for the Devil Canyon and Watana projects. A project constructed without provision for multi-level withdrawal would result in a reservoir thermal regime which, when released to the downstream channel, would produce an annual temperature pattern completely reversed from the normal condition. Since temperature is perhaps the greatest normal physical parameter which affects downstream water quality from both a chemical and biological standpoint, it is imperative that the reservoirs' temperature releases not cause detrimental downstream effects. In conjunction with the temperature releases, it will be necessary to insure that the downstream dissolved oxygen levels are also maintained at an acceptable level. Attainment of these two goals can be met through a computer modeling of the reservoir to determine the optimum number and spacing of the proposed multi-level intake structures. Physical data required for this type of study would include the reservoir geometry, reservoir operating procedure, natural temperature regime, and annual reservoir inflow and outflow.

Seasonal Constraint: None

Cost: $150,000

ENVIRONMENTAL

Activity Designation: EN-3

Activity: Analyze spillway and outlet works for dissolved gas production.

Description: Experience gained from operation of water projects in the Pacific Northwest indicates that the most efficient spillway and outlet works design from the standpoint of hydraulic dissipation of energy is not necessarily the most advantageous means of maintaining downstream water quality. Care must be taken to insure that the design does not impart excessive amounts of dissolved gasses to the downstream channel, which could possibly have a detrimental affect on resident and anadromous fisheries. The Devil Canyon gorge should be analyzed to determine its natural capability to dissipate dissolved gasses for a range of flows. Much work has been accomplished in this area, and it should be possible to insure that dissolved gasses will not pose a problem for the selected plan.

Seasonal Constraint: Water monitoring during the summer months.

Cost: $20,000

ENVIRONMENTAL

Activity Designation: EN-4

Activity: Assess erosion potential in active storage zone.

Description: The purpose of this study will be to develop a preliminary soil erosion hazard map for the Susitna hydroelectric reservoir clear zone. Mapping will be accomplished utilizing black and white aerial photography along with ERTS imagery, with sufficient ground truth mapping to confirm the identification of soil types. All soil types will be classified in the clear zone as to their potential erosion hazard. The cost associated with mapping is included under survey requirements. In addition, much mapping is presently being accomplished by the Bureau of Land Management and Soil Conservation Service.

Seasonal Constraint: Summer ground truthing.

Cost: $20,000

ECONOMICS (EC)

THE ACTIVITIES IN THIS CATEGORY ARE DIRECTED AT DETERMINING AND ASSESSING THE SOCIO-ECONOMIC EFFECTS OF THE PLANNED DEVELOPMENT FROM LOCAL, REGIONAL, AND STATEWIDE PERSPECTIVES. IMPACTS ASSOCIATED WITH FLOODING AND WITH THE UTILIZATION OF OTHERWISE UNEMPLOYED LABOR IN PROJECT CONSTRUCTION ARE GIVEN SPECIAL ATTENTION, WHILE THE REMAINDER OF THE ACTIVITIES ADDRESS ALL OTHER EFFECTS, SUCH AS LIVELIHOOD, LIFESTYLE, AND COMMUNITY.

MISCELLANEOUS ECONOMIC STUDIES.

1. Perform employment benefit analysis.
2. Prepare flood damage prevention analysis.

SOCIO-ECONOMIC IMPACT STUDIES.

3. Conduct preliminary socio-economic impact studies for initial screening of alternatives.
4. Develop detailed profiles of socio-economic conditions in the immediate project area, the region, and the State.
5. Forecast future "without-project" conditions.
6. Forecast future "with project" conditions.
7. Identify and evaluate significant socio-economic effects.

ECONOMIC STUDIES

Activity Designation: EC-1

Activity: Perform employment benefit analysis.

Description: Employment of otherwise unemployed or underemployed manpower in construction and installation of a proposed plan is considered a beneficial contribution to national economic development objectives. This category of benefit is conceptually an adjustment to the cost of a project, because there is no economic cost associated with the use of an otherwise unemployed resource. Benefits attributable to unemployed and underemployed labor used in construction and installation of a plan will be included in total plan benefits, but projects will be formulated and scaled without consideration of employment benefits. First, the estimated number of employed and unemployed construction workers in the region will be determined with the assistance of the State Department of Labor. Next, an estimate will be made of the number of construction workers required for other construction projects in the region. This estimate will be made after consultation with State and Federal planners as well as knowledgeable individuals in the construction industry. The labor costs and manpower requirements associated with the proposed project will be estimated, with detailed consideration for all major skill categories. The State Department of Labor will be contacted to determine average regional wage rates for each of the major skills identified. The next step will be to estimate the proportion of project wage payments for each skill that will go to otherwise underemployed or unemployed workers. Finally, the total of wage payments to otherwise unemployed or underemployed labor will be converted to an average annual basis.

Seasonal Constraint: None

Cost: $5,000

ECONOMIC STUDIES

Activity Designation: EC-2

Activity: Prepare flood damage prevention analysis.

Description: Though limited, the incidental flood control benefits will be estimated and included in total project benefits. Construction of the Susitna project will reduce flood stages along the Susitna River downstream from the proposed Devil Canyon dam. The purpose of this activity will be to evaluate the savings, if any, in property damage and loss that will result from the reduction of flood stages. In accomplishing this analysis, the extent of the affected area will be delineated based on hydrological studies of stream discharge volume and frequency and water profiles downstream from the project. The characteristics of the flood plain will be determined together with the present land use patterns. Based on forecasts of regional economic activity, land-use demand will be estimated and land use with and without the project will be projected. The nature of flood damages will be assessed, and flood damages with and without the project will be estimated. Finally, flood damage prevention benefits will be computed as the difference between damages with and without the project. Benefit categories that will be considered will include land-use intensification and location benefits as well as the reduction of property damages resulting from inundation. The econmic feasibility of providing flood control storage will be determined.

Seasonal Constraint: None

Cost: $12,000

ECONOMIC STUDIES

Activity Designation: EC-3

Activity: Conduct preliminary socio-economic impact studies for initial review of alternatives.

Description: For the purpose of preliminary screening, a general socio-economic conditions profile will be constructed from available reports. Also, future conditions will be projected utilizing available reports or standard forecasting techniques. Both of the preceding will be limited to standard socio-economic parameters and will in general be an overview. Impacts that various alternative plans may have in these projections will be discussed in a general fashion. This analysis will permit comparison of plans, pinpointing of areas of concern for later study, and identification of communities or areas requiring detailed analysis.

Seasonal Constraint: None

Cost: $11,000

ECONOMIC STUDIES

Activity Designation: EC-4

Activity: Develop detailed profiles of socio-economic conditions in the immediate project area, region, and the State.

Description: This and the following economic studies outline a thorough investigation of socio-economic impacts for use in the detailed feasibility analysis.

The "immediate project area" is that area receiving direct long- and short-term impacts of construction and operation of the project. A profile of existing conditions will be developed from the perspective of the individual and of the local governments. Descriptions will include public services, tax structure, property values, population distributions and trends, local employment data, life styles, community relationships, land use programs, etc. The "region" will include the area directly affected by utilization of project outputs. The profile will emphasize those socio-economic factors affected by this utilization, including population distributions and trends, employment/unemployment data, current power usage patterns, industrial base, and generalized regional conditions. Where necessary, specific factors will be separated from the more general and given special attention. Similar "State-wide" socio-economic conditions and parameters will be presented for comparison. In addition, areas likely to specifically constitute an impact to the State will be addressed, including tax structure and financial conditions. Regional and State profiles can draw heavily on the base study completed under activity PM-2.

Seasonal Constraint: None

Cost: $15,000

ECONOMIC STUDIES

Activity Designation: EC-5

Activity: Forecast future "without-project" conditions.

Description: To assess project impacts a long-term forecast of future conditions "without the project" will be required for the immediate project area and the region. The forecast for the immediate project area will be completed after interviews with local officials, consideration of local desires and aspirations, review of land use and other programs, and utilization of standard forecasting techniques. The results will be translated to parameters consistent with the socio-economic profile. The regional "most probable future" will be obtained largely from other study efforts (activities PM-3 and PM-4), and should only require tailoring to be consistent with profile data. One area of additional forecasting effort will be in those situations where specific industrial or other specialized impacts are anticipated. Primary effort will be toward local projections needed for impact analysis. Regional projections will draw on activities PM-3, 4, 7, & 9.

Seasonal Constraint: None

Cost: $15,000

ECONOMIC STUDIES

Activity Designation: EC-6

Activity: Forecast future "with-project" conditions.

Description: The plans reviewed during the detailed feasibility analysis will be assessed to identify impacts they might have on local or regional conditions. This will require a forecast of both short-term conditions during and just after project construction and long-term estimates during the life of the project. Short-term forecasts will estimate how immediate project area conditions are expected to change, including: additional requirements placed on local public services, changes in population and employment characteristics, specific industry impacts, and changes in community relations. Long-term forecasts of "with project conditions" will involve both immediate project and regional areas. Local conditions are expected to be affected primarily by physical presence and operation of the project, along with holdover effects from construction activity. Regional conditions will be affected more by development differences that occur because of type, cost, and timing of a plan. Where specific regional impacts (e.g., the coal industry) are observed, special emphasis will be required.

Seasonal Constraint: None

Cost: $20,000

ECONOMIC STUDIES

Activity Designation: EC-7

Activity: Identify and evaluate significant socio-economic effects.

Description: This activity will identify, describe and measure, when possible, the significant socio-economic impacts of each plan, and validate the results via public and agency review. After completion of a socio-economic profile and the with/without project forecasts of local and regional conditions, the impacts will be ordered so that significant impacts can be selected. A columnar impact/project format has usually been used so all alternative plans can be displayed side by side for ease of comparison. Input from the public and appropriate agencies will be requested to assure that all significant impacts have been addressed. The results of this activity will be presented in the Environmental Studies Appendix.

Seasonal Constraint: None

Cost: $6,000

RECREATION (R)

THESE ACTIVITIES ARE INCLUDED FOR THE PURPOSE OF DETERMINING THE DEMAND FOR VARIOUS TYPES OF RECREATION THAT COULD BE ASSOCIATED WITH THE HYDROELECTRIC DEVELOPMENT, FORMULATING AND EVALUATING VARIOUS RECREATION PLANS, AND FINALLY SELECTING THE MOST PROMISING RECREATION SCHEME.

RECREATION PLAN

1. Conduct data search and evaluation.
2. Conduct supply and demand analysis.
3. Develop alternative plans for public recreation and related resources uses.
4. Conduct cost/benefit evaluation of alternative plans and select final plan.

RECREATION

Activity Designation: R-1

Activity: Conduct data search and evaluation.

Description: A preliminary data search will be performed to insure that all available information pertinent to subsequent study activities is located and documented. This search will primarily concentrate on data available from other agencies concerning recreation market analysis and project recreation development potential and constraints.

Seasonal Constraint: None

Cost: $5,000

RECREATION

Activity Designation: R-2

Activity: Make supply/demand analysis of the recreation market area, and determine market area needs for outdoor recreation opportunities and facilities.

Description: The recreation market area will be defined and mapped to account for both day-use and overnight-use visitors. The market area's present and projected socio-economic characteristics will be described and evaluated to assess their effect upon the recreation needs and requirements of the market area consumer. The recreation activity preferences of the market area consumer will be determined and described utilizing available data as well as through a public involvement program. Existing and planned outdoor recreation facilities within the market area will be inventoried, described, and mapped. This will require close coordination with the State of Alaska Division of Parks, other Federal and State agencies, and private entrepreneurs. Current and projected market-area recreation demands will be determined, based upon evaluation of the above factors. Comparative analysis of supply and demand relationships will provide insight into facility/opportunity surpluses or deficiencies within given increments of time.

Seasonal Constraint: None

Cost: $20,000

RECREATION

Activity Designation: R-3

Activity: Develop alternative plans for public recreation and related resources uses.

Description: The outdoor recreation facility/opportunity needs of the market area consumer will be synthesized with the physical and biological features of the project. Initial and future outdoor recreation development alternatives and alternatives for other related resource uses will be described and mapped. Alternatives so described will relate to market area recreation needs and to the constraints, potentials, and capabilities of the project's resources. Initial and future levels of visitor attendance will be determined for each alternative plan by calculating instantaneous use, turnover factors, seasonality, and ratios of activity duplication. Ultimate use, or maximum practical use, will be calculated in recognition of limitations imposed by low demands and resource capacity. Development measures for enhancing environmental quality and aesthetics associated with project structures, roads, and other features will be planned and described in detail. A public involvement program will be required, together with close and continued coordination with the State. Field inspections of the project area will be important aspects of this activity.

Seasonal Constraint: Field inspections must be conducted during the summer months.

Cost: $15,000

RECREATION

Activity Designation: R-4

Activity: Evaluate costs and benefits of alternative plans for public recreation and related resource uses, and select best alternative.

Description: The information generated in activities R-2 and 3 will be evaluated in order to attach dollar values to the phased development alternatives. Development costs as well as the operation, maintenance, and replacement costs for each alternative must be amortized in order to determine the average annual costs for these functions. Benefits will be determined through economic analysis for projected attendance in conjunction with each alternative to arrive at average annual attendance. User-day values will be assigned to these attendance figures to arrive at average annual benefits. Selection of the final alternative will depend upon public input as well as upon the desires and financial capabilities of the State of Alaska.

Seasonal Constraint: None

Cost: $16,000

PLAN FORMULATION (PF)

THESE PLAN FORMULATION ACTIVITIES SPECIFY THE PROCESS USED BY THE PLANNER IN DEVELOPING THE BEST CONCEPTUAL PLAN OF DEVELOPMENT FROM AMONG THE RANGE OF POSSIBILITIES, AND IN THEN REFINING THAT PLAN INTO ONE WHICH BEST SATISFIES THE REGION'S WATER RESOURCE NEEDS. TO ASSIST IN THIS ENDEAVOR, THE PLAN FORMULATOR EMPLOYS ALL THE INFORMATION RELATED TO PLAN BENEFITS, COSTS, AND ENVIRONMENTAL EFFECTS DEVELOPED BY THE VARIOUS OTHER DISCIPLINES.

REVIEW OF PREVIOUS STUDIES.

1. Review 1976 feasibility report.
2. Update power values.

EVALUATION CRITERIA.

3. Establish evaluation criteria.

PLANS AND PRELIMINARY EVALUATION.

4. Identify possible solutions.

ANALYZE SPECIFIC PLANS OF HYDROPOWER DEVELOPMENT.

5. Establish site layouts.
6. Conduct mass take-offs and provide cost estimates.
7. Assess reregulation dam costs.
8. Develop power benefits and assess economic attractiveness.

IMPACT IDENTIFICATION AND EVALUATION.

9. Make preliminary assessment of alternatives.

ON-GOING EVALUATION OF ALTERNATIVES.

10. Update the impact analysis as needed.

IDENTIFICATION OF HYDRO SYSTEM OPERATION IN REGIONAL LOAD.

11. Study feasibility of future units and downstream reregulation.
12. Conduct hourly loading studies.
13. Assess sensitivity to load growth.

ALTERNATIVE SYSTEM STUDIES.

14. Conduct system studies on alternative developments.

BENEFIT AND COST CALCULATION.

15. Collect and compare benefit and cost estimates.

PLAN FORMULATION

Activity Designation: PF-1

Activity: Review 1976 feasibility report.

Description: Review the preauthorization feasibility report to identify formulation tasks which have already been completed and can serve as direct input to the present Plan Formulation efforts. This will include a review of alternative development plans to determine if they should be reanalized in more depth as a result of an updated data base. Those conclusions which are still current will be used directly in the formulation process.

Seasonal Constraint: None

Cost: $1,000

PLAN FORMULATION

Activity Designation: PF-2

Activity: Update power values.

Description: Benefits and costs of the several alternative plans must be calculated on a comparable basis. This will necessitate updating the power values upon which power benefits are based. The power values are the costs of capacity and energy produced by the most economical available nonhydro alternative, in this case coal generation. The power values used in the 1976 Feasibility Report will be updated to reflect changes in generation cost since 1975. These updated power values will be utilized during the preliminary screening, while more refined values developed in conjunction with activity PM-11 will be used in the detailed feasibility analysis.

Seasonal Constraint: None

Cost: $3,000

PLAN FORMULATION

Activity Designation: PF-3

Activity: Establish evaluation criteria.

Description: This activity will be aimed at describing the marketing and technical parameters associated with hydroelectric that will be used in evaluating the energy capabilities of the various alternative developments, and the economic value of the resource. Technical criteria will entail such aspects as tailwater rating curves, hydraulic loss curves, evaporation rates, leakage and seepage losses, transmission losses, sedimentation rates, operating rule curves, drawdown limitations, etc. Criteria associated with economics would entail seasonal energy demand, projected energy and capacity requirements, a projection of usable energy and capacity, and an estimate of the unit value of prime energy, secondary energy, dependable capacity, and interruptible capacity. The objectives are the National, State, and local water and related land resource management needs specific to the railbelt area that can be addressed to enhance national economic development and environmental quality. During the preauthorization studies, specific objectives were identified from expressions of governmental agencies, industry, special interest groups, and private citizens. They included a projected need for increased supplies of electrical energy, a need for reduction or prevention of flood damages, a need for improved small boat and deep draft navigation conditions, a need for increased municipal water supply, a need for future supplies of irrigation water, a need for reduction of air pollution in Fairbanks and Anchorage, a need to conserve and enhance fish and wildlife resources, a need for additional recreation opportunities, a desire to preserve and maintain "the Alaskan way of life," a national desire to achieve energy independence, and the national desire to conserve nonrenewable resources. It will be necessary to reevaluate these objectives based on national policy and expressions of desires to be obtained from public input.

Seasonal Constraint: None

Cost: $5,000

PLAN FORMULATION

Activity Designation: PF-4

Activity: Identify possible solutions.

Description: This activity will be aimed at identifying the alternatives available to meet the study objectives. The purpose will be to insure that all alternatives are evaluated during the screening and evaluating process. This will require an inventory of resources available within the immediate area. It will also entail a literature review to ascertain the present state-of-the-art associated with developing some of the exotic resources. This will entail a review of the economics and environmental impacts. Finally, specific development ideas mentioned in previous documents and reports for the railbelt area will be identified. The pre-authorization report identified the following energy alternatives: coal, natural gas, oil, wind, tide, geothermal, solar, no growth, nuclear, wood, intertie, solid waste, and hydropower. To this list might be added soft techniques or others which may become available during the planning phase. This activity will include refining alternative plans without concentrating on detailed engineering and design considerations. These alternative plans will help to make obvious the consequences that concentration on one of the other objectves will cost in terms of the remaining objectives. Thus, considering each alternative's contribution to the national and local objectives will disclose that many of the alternatives can be eliminated without an indepth analysis. The first screening will eliminate the obviously unfulfilling alternatives because of their economic inferiority or detrimental effect on the environment.

Seasonal Constraint: None

Cost: $8,000

PLAN FORMULATION

Activity Designation: PF-5

Activity: Coordinate site layout activities.

Description: This activity will entail the identification of specific damsites that could be developed within the Upper Susitna Basin, and the combinations of dams which would compose the various systems of development. For each proposed system, major project features will be laid out and reconnaissance-grade design will be accomplished. This will insure that major features are compatible with the local topography and foundation conditions. Major attention will be given to dam heights and types of structures. The selection of plans to be evaluated will be accomplished by the organization responsible for reservoir regulation studies. That organization, however, will have to work closely with foundations and materials specialists to insure that specific sites appear to be feasible to develop. Each dam evaluated will require that a number of structural heights are analyzed. This will insure optimum scoping of each project.

Seasonal Constraint: None

Cost: $40,000

PLAN FORMULATION

Activity Designation: PF-6

Activity: Conduct mass take-offs and develop cost estimates.

Description: The only plan of development that will be cost estimated in detail will be the plan recommended for final development. Thus, during plan formulation, the estimates will be of reconnaissance grade. This will require mass take-offs to which unit prices can be affixed. For each damsite evaluated, it will be necessary to provide cost estimates for a variety of dam heights and structural types. The estimates should be of sufficient detail, however, that they are compatible with the detailed cost estimate for the selected plan. Estimates will be for all design features (transmission line, powerhouse, dam, spillway, access road, etc.) based on present-day price levels. Contingencies should be in the 15 to 20 percent range.

Seasonal Constraint: None

Cost: The cost and duration of this activity has been included under the design consideration portion of the Plan of Study.

PLAN FORMULATION

Activity Designation: PF-7

Activity: Include reregulation dam in costs if necessary.

Description: Based on activity PS-3, if it is determined that a reregulation dam is necessary, then the design and cost of such a structure would be required. The possibility of installing generating capacity in the reregulator should also be explored. This would also require that sufficient environmental information is gathered to allow for effect assessment of downstream effects.

Seasonal Constraint: None

Cost: $1,000

PLAN FORMULATION

Activity Designation: PF-8

Activity: Develop preliminary power benefits and assess economic attractiveness.

Description: The purpose of this activity will be to determine the economic value of the major plans for development in light of the criteria established under the power marketing analysis. In essence, it will entail comparing project benefits to project costs. Project benefits can estimated by determining the amounts of energy and capacity that can be absorbed into the load during the life of the project. This will be influenced by the load growth of the area, the amount of thermal generation in the existing system, the condition of the existing generation, and the value of the hydro in relation to new and existing energy plants. Then by determining the value of the hydro (which is really the cost of developing the most feasible alternative to hydro and comparing this to the cost of hydro development), the economic value of the various alternatives can be determined. The value of the hydro should be estimated by a life cycle analysis of the energy resource that would be developed in lieu of the hydro project. Thus the replacement cost and future value of the fuel and O&M components will be present worthed to a present day value. This will be compared against the amortized cost of project construction.

Seasonal Constraint: None

Cost: $10,000

PLAN FORMULATION

Activity Designation: PF-9

Activity: Make preliminary assessment of alternative plan costs, benefits, and impacts.

Description: This screening analysis will attempt to narrow the choice of available alternatives down to a chosen few which will be evaluated in specific detail. Thus, the screening process will be accomplished in three phases. This second stage will be based on a more indepth analysis of the environmental impacts and economics of specific plans for development than was accomplished under the first screening. Thus, reconnaissance grade cost estimates and benefit assessments will be necessary as will effect assessment. The alternatives will be evaluated in terms of the contribution to State and national economic objectives as well as to environmental preservation. Only those plans that appear to be economically feasible will be considered for plan selection. From this screening will come a detailed comparison of the remaining alternatives (presumably hydropower and coal) as to their relative environmental and socio-economic impacts. Determination of impacts will require a reasonable degree of accuracy at this stage, which in turn is dependent upon sufficient structural and design detail to more precisely evaluate the differences among the remaining alternatives. Detailed effects on water and land resources and economic and social aspects of human use will be measured or described by a determination of incremental changes in the applicable factors of affected environmental components. Wherever possible this will require quantification, particularly of effects on water and land resources. The same factors will be quantified for each alternative. Evaluation of the alternative plans in terms of environmental preservation will reflect societal preferences for the environmental contributions to the alternative plans. This will actively address the planning objectives in a way which emphasizes, aesthetic, ecological, and cultural contributions. Since it is assumed that strict adherence to environmental preservation will significantly preclude physical construction or development, it is necessary that some positive action be identified to assure that a "no development" plan be realized. Consequently, energy evaluation will require an interpertation of State objectives toward economic development.

Seasonal Contraint: None

Cost: $5,000

PLAN FORMULATION

Activity Designation: PF-10

Activity: Update the impact analysis as needed.

Description: For each of the several alternative plans that are carried beyond the second screening, the tabulation of plan impacts will be kept updated. As phase I studies progress and as plans are refined, significant impacts will be identified and evaluated through various impact studies discussed elsewhere. This activity will consist of drawing upon these studies to develop an on-going table of differential plan impacts for use in impact assessment and plan formulation.

Seasonal Constraint: None

Cost: $20,000

PLAN FORMULATION

Activity Designation: PF-11

Activity: Study feasibility of future units and downstream reregulation.

Description: From the production cost model (PS-4), the need for and timing of additional units will be determined. From the routing studies (PS-2) and related environmental studies, the need for a reregulator will be determined. With data on most likely thermal alternative (PM-11 and PS-4), benefits will be computed. With data on cost of added units and reregulator, economic feasibility of added units will be determined. It may be desirable to test several rates of load growth to see if they have any impact on feasibility of added units. The study will have to consider sunk costs and present worth of future costs and benefits.

Seasonal Constraint: None

Cost: $4,000

PLAN FORMULATION

Activity Designation: PF-12

Activity: Conduct hourly loading studies.

Description: Studies must be made to determine the most likely loadings of Susitna hydro on an hourly basis. This must be done as input for streamflow routing studies. It will also serve as input data on hourly system load growth studies and will be done for selected times of the year (one for each definable season, at least) and for various points in time (5- or 10-year intervals from 1985 to 2015). Using input data on other available generating resources (PM-5 & 10), loading of Susitna hydro under the various conditions will be done with the help of the production cost model (PS-4).

Seasonal Constraint: None

Cost: $3,000

PLAN FORMULATION

Activity Designation: PF-13

Activity: Assess sensitivity to load growth.

Description: This activity will entail an assessment of the economics of the selected plan should the projected load growth be significantly greater or less than that anticipated.

Seasonal Constraint: None

Cost: $1,000

PLAN FORMULATION

Activity Designation: PF-14

Activity: Conduct system analysis studies on alternative developments.

Description: These studies will be conducted in order to evaluate the capability of the alternative development to meet system loads. Presumably, coal fired generation will be selected as the most viable alternative to Susitna hydro. By analyzing the coal alternative using the "Production Cost" model, it will be possible to determine how the coal alternative will fit into the integrated load system and if it provides a more flexible alternative than the hydro system. The study may highlight a need for a variety of generating modes that could meet the total system capacity requirements. The study would also indicate the desirability of interconnecting the Anchorage and Fairbanks load centers.

Seasonal Constraint: None

Cost: $20,000

PLAN FORMULATION

Activity Designation: PF-15

Activity: Compare benefit and cost estimates.

Description: This activity will entail the development of the economics of the selected plan of development. It will include a synopsis of the total cost of the selected plan based on a given time frame. Costs will include total construction costs, interest during construction, engineering and design costs, supervision and administration of construction, and operation and maintenance of the projects. These costs will be amortized at the selected interest rate over the payout period of the project, thus providing an average annual cost. The benefits will also be estimated on an annual basis and will essentially represent the cost of providing an equivalent amount of power by the most likely alternative to the selected plan. A comparison of the benefits and costs will indicate the economic attractiveness of the selected plan.

Seasonal Constraint: None

Cost: $3,000

POWER STUDIES (PS)

THIS GROUPING OF DIVERSE ACTIVITIES INCLUDES THE ANALYSES NEEDED TO ESTABLISH THE ENERGY CAPABILITIES OF THE VARIOUS ALTERNATIVE PLANS OF DEVELOPMENT OVER A RANGE OF ASSUMED DAM HEIGHTS AND STORAGE VOLUMES. ALSO, STUDIES ASSESS THE NEED FOR REREGULATION OF STREAMFLOWS DOWNSTREAM FROM THE PROJECT AND HELP DETERMINE THE OPTIMUM MODE OF OPERATION FOR THE SELECTED PLAN.

MISCELLANEOUS POWER STUDIES

1. Identify optimum dam heights, reservoir storage and optimum power.
2. Conduct hourly simulated operation.
3. Evaluate downstream impacts with and without a regulating dam.
4. Develop production cost model.

POWER STUDIES

Activity Designation: PS-1

Activity: Identify optimum dam heights, reservoir storage, and optimum power from seasonal regulation studies.

Description: Based on the power available from the various schemes of development and the multitude of combinations of dam heights, types of dam, stage sequences, etc., it should be possible to develop a number of total construction cost estimates for each scheme and combination analyzed. Assignment of benefits based on the combinations for each scheme analyzed should allow identification of the optimum components associated with power development. This would include optimum dam height, maximum drawdown determination, optimum staging, etc. From this type of analysis, the optimum combinations associated with each development scheme can be selected for effect assessment under the preliminary screening. This activity will encompass a description of the turbine specifications and operational capabilities of the selected plan of development. This will require efficiency curves for the turbines and a description of the turbines' operational limits. The limits will entail determination of such items as maximum head, minimum drawdown, tailwater rating curves and placement of the turbine to preclude damage to the turbines caused by low pressure (cavitation). Efficiency curves can be computer-generated or they may be obtained from manufacturers.

Seasonal Constraint: None

Cost: $40,000

POWER STUDIES

Activity Designation: PS-2

Activity: Conduct hourly operation simulations.

Description: Conduct hourly simulated operation for the more feasible plans, and route them downstream. The work will consist of developing the data for the basic mathematical model consisting of downstream channel geometry, project characteristics, variations in the daily power load for the system, and other similar information. This will be followed by model calibration to insure that the natural system is being properly simulated. It will then be necessary to determine the situations under which the project will operate. This will entail determining seasonal water conditions and seasonal power load shapes, number of electrical generation units at each project, the amount of capacity in each powerhouse, and the availability of a reregulation dam. Results of hourly simulations will be evaluated to determine the effects downstream from the standpoints of navigation and recreation safety, the effects on the winter ice cover, and the effects on the downstream environment.

Seasonal Constraint: None

Cost: $70,000

POWER STUDIES

Activity Designation: PS-3

Activity: Evaluate, for feasible plans, the downstream impacts with and without a reregulating dam.

Description: Downstream routing studies of powerhouse discharges for the more feasible plans of development will be required to determine water level fluctuations that can be expected to occur. The river reach to be studied will be from the Watana project downstream to the town of Talkeetna. Since detailed channel geometry will be available from the water surface profile determinations (HY-16), it is likely that the Gradually Varied Unsteady Flow Computer Program (SOCH) will be utilized. This program is a finite-difference solution to the complete equations of unsteady flow in open channels. The program was originally developed by TVA, and modified slightly by the Corps Hydrologic Engineering Center. It employs detailed channel geometry taken from surveyed cross-sections of the river and estimated channel roughness factors to provide the solution. Evaluation of downstream impacts will require a comparison between simulations with and without reregulation for water surface changes on an hourly, daily, and seasonal basis.

Seasonal Constraint: None

Cost: $40,000

POWER STUDIES

Activity Designation: PS-4

Activity: Develop production cost model.

Description: This mathematical model will be used to determine the optimum role of Susitna hydro in contributing to the total power load of the Railbelt Area at various points in time (1985-2015), and hence the value of the energy to the system, and the possible need for and timing of additional units (PF-15). It will also aid in the selection of the thermal alternative(s) upon which benefits will be based (PM-11). The work will involve setting up the numerical model for the Railbelt Area, and then developing a program based on a number of scenarios for development of the market area. This will be followed by a series of studies to determine the optimum role of Susitna hydro at various points in time (5- or 10-year intervals, 1985-2015). In similar fashion it will be necessary to evaluate the various thermal alternatives in order to determine the least-cost alterantive capable of doing the same job. Then, based on long-range power demand projections, evaluation will be accomplished of additional units for the selected plan at various points in time. Various sensitivity tests will be made as required, such as the impact of different rates of load growth, impact of load shape management, and impact of fuel cost escalation.

Seasonal Constraint: None

Cost: $48,000

POWER MARKET STUDIES (PM)

THESE ACTIVITIES ADDRESS THE NEED FOR POWER AND THE SALEABILITY OF POWER IN THE REGION. FIRST, ELECTRICITY NEEDS ARE FORECAST BASED ON ESTIMATES OF FUTURE ECONOMIC ACTIVITY LEVELS, POPULATION GROWTH RATES, AND PER CAPITA USE. THE TIMING OF THE POWER DEMAND IS ASSESSED, AS WELL AS THE CAPABILITY OF EXISTING AND PLANNED GENERATION FACILITIES TO SATISFY THE ANTICIPATED DEMAND. THE COST OF SUPPLYING THE POWER BY MEANS OTHER THAN HYDROELECTRIC GENERATION ARE DETERMINED, AND FINALLY THE FINANCIAL FEASIBILITY OF THE SELECTED PLAN IS EXAMINED.

PRELIMINARY LOAD GROWTH ANALYSIS

1. Update power market analysis from feasibility report.

DETAILED LOAD GROWTH AND POWER MARKET ANALYSIS

2. Prepare socio-economic base study.
3 Forecast future development.
4. Prepare employment and population forecasts.
5. Describe existing and planned power generation through 1985.
6. Assess electric energy use trends.
7. Develop electricity demand forecasts by sector.
8. Develop load distribution data and duration curves.
9. Assess long term power outlook and system requirements.
10. Evaluate the retirement of existing and planned power plants.
11. Evaluate alternative power sources.
12. Assess project financial feasibility.

FERC LICENSE

13. Prepare material for draft FERC License.

POWER MARKET STUDIES

Activity Designation: PM-1

Activity: Update power market analysis from feasibility report.

Description: The load growth forecast and marketing assumptions on which the 1976 feasibility report was based will be reviewed. Assumptions of these earlier analyses will be checked against actual events and more recent information and studies. Adjustments will be made as the need is indicated. This activity only constitutes an initial analysis for the purpose of preliminary screening; it will be followed by an extensive power market study that will span the succeeding 2 years and which will be utilized in the detailed feasibility analysis.

Seasonal Constraint: None

Cost: $6,000

POWER MARKET STUDIES

Activity Designation: PM-2

Activity: Prepare socio-economic base study.

Description: The purpose of this activity is to provide a baseline analysis of the region, which will serve as the basis of forecasting future economic development, employment and population growth, and electric energy demand. The study will define the limits of the region and describe its salient physical features and climatic conditions. Existing data and reports on natural resources of the region will be reviewed, and a fairly detailed discussion of signficant natural resources within or directly affected by the region will be represented. Present land use patterns will be described and discussed. Historical and present demographic trends including population characteristics, labor force participation, and employment and unemployment will be evaluated. In addition, major industries within the region will be described, and historical and present economic development trends will be discussed.

Seasonal Constraint: None

Cost: $75,000

POWER MARKET STUDIES

Activity Designation: PM-3

Activity: Forecast future development.

Description: The purpose of this activity will be to prepare a range of forecasts of future economic developments and to identify the most probable forecasts. The analysis will be based upon the findings of the baseline socio-economic studies of the region. Alternative assumptions and development scenarios will be formulated, and will be presented to support the range of forecasts that will be derived. Existing econometric models of the region and State will be reviewed, and if possible adapted for use in making the actual forecasts. Since the economic life of the project is 100 years, forecasts will be made for the short-term (present to 1985), intermediate (1986-2036), and long-term (through the end of the project life) conditions. Short- and intermediate-term forecasts will be relatively detailed, while long-term projections will be shown by decade. Those forecasts will serve as the basis for employment and population forecasts.

Seasonal Constraint: None

Cost: $28,000

POWER MARKET STUDIES

Activity Designation: PM-4

Activity: Forecast employment and population growth.

Description: This activity will follow activity PM-3. The purpose of the employment forecast is to establish a basis for making the population forecast. Both forecasts are required input to the forecast of electrical energy demand. Forecasts will be made in detail comparable to that used for preparation of the economic development forecast, activity PM-3.

Seasonal Constraint: None

Cost: $11,000

POWER MARKET STUDIES

Activity Designation: PM-5

Activity: Describe existing and planned power generation through 1985.

Description: To determine the optimum role for the Susitna project in meeting the area load, and hence the plant size, it is necessary to describe the system of projects with which Susitna hydro will operate. This will involve inventorying the existing and committed generating resources in the Railbelt Area, and projecting the most likely mix of additional resources which would be built to handle load growth through 1985. In addition, the existing resources will be reviewed to determine if some plants would likely be retired or placed on standby reserve. (Data will be required on plant operating characteristics and costs for input to production cost model PS-4). Most of the data will come from the local utilities and the Federal Power Commission.

Seasonal Constraint: None

Cost: $3,000

POWER MARKET STUDIES

Activity Designation: PM-6

Activity: Assess electric energy use trends.

Description: The purpose of this activity will be to evaluate historical and current factors which influence the use of electricity within the region. Historical data on electric energy use will be reviewed and evaluated, and trends will be established. Factors which have historically had and/or which probably will have a significant impact on future electric energy use-trends will be considered. Such factors will include but not be limited to the outlook for energy conservation, efficiency in energy use, and the outlook for future energy-intensive industries.

Seasonal Constraint: None

Cost: $15,000

POWER MARKET STUDIES

Activity Designation: PM-7

Activity: Develop electricity demand forecasts by sector.

Description: The purpose of this activity will be to bring together the results of activities PM-3, 4, and 6, and develop forecasts for regional electricity demand. These forecasts will be made in detail and scope which is comparable to those made during activities PM-3 and 4. In making the analysis, each sector (residential, commercial/industrial, municipal, and other) will be evaluated separately. An integral part of the study will be to assess the sensitivity of demand to relative price changes among energy sources and to evaluate the substitutability of alternative energy sources for energy-intensive industries.

Seasonal Constraint: None

Cost: $50,000

POWER MARKET STUDIES

Activity Designation: PM-8

Activity: Develop load distribution data and duration curves.

Description: This activity will entail developing monthly load duration curves, developing annual distribution of load by month, and developing typical daily load shapes for selected times of the year and residual daily load shapes to be carried by hydro. This will involve obtaining historical load data from utilities, Alaska Power Administration and the Federal Energy Regulatory Commission, plotting it in the various formats described above, and making adjustments to reflect projected conditions at various future points in time (at 5- or 10-year intervals from 1985 to 2015). Some of this data has already been developed under prior studies. Development of residual hourly load shapes at various points in time will be done in concert with production cost model studies. (PS-4)

Seasonal Constraint: None

Cost: $15,000

POWER MARKET STUDIES

Activity Designation: PM-9

Activity: Assess long term power outlook and system requirements.

Discription: The purpose of this activity will be to bring together the results of long-term electrical energy demand forecasts (activity PM-7) and the preliminary results of power production cost studies (PS-4) in a computer analysis which will identify the probable future power generation system requirements in the region. The principal function of this study will be to predict the most economical additions to the system in the future and to identify the most economical operational position in the future power system for the proposed Susitna project. System capacity and peaking requirements will be analyzed and possible future modifications of the project will be identified. To determine the system energy benefits for Susitna hydro, the role of Susitna hydro in the future system, and the possible need and timing of additional units, it will be necessary to describe operation of the system at various future points in time (5- or 10-year intervals from 1985 to 2015). To do this it will be necessary to describe the mix of generating resources that will likely develop post-Susitna. Consistent with load growth projections, one or more likely systems of additional generating resources will have to be developed. In addition to the projected generating resource mix, data will have to be developed on operating characteristics and costs for PS-4. Retirements of existing generation will have to be considered. Development of the projected systems will be a reiterative process with PS-4.

Seasonal Constraint: None

Cost: $25,000

POWER MARKET STUDIES

Activity Designation: PM-10

Activity: Evaluate the retirement of existing and planned power plants.

Description: This activity is a detailed assessment of specific Railbelt Area utilities with regard to necessary actions on their part to accommodate the recommended plan of development. The impact of the development on the local utilities will be identified and evaluated.

Seasonal Constraint: None

Cost: $14,000

POWER MARKET STUDIES

Activity Designation: PM-11

Activity: Evaluate alternative power sources.

Description: The purpose of this activity will be to establish the cost of generating electricity in the region by thermal plants. This cost data will establish the baseline or alternative condition against which the economic feasibility of hydroelectric generation in the Susitna will be measured. The study will examine recent industry trends in energy and capacity costs. It will review and establish the availability of various types of fossil fuels for thermal generation; the cost trends of those fuels will be examined on a regional, State, and national basis. Future real cost increases for fuel will also be considered. Engineeringly feasible thermal power generation alternatives will be identified, and construction and operational costs will be examined in order to establish power and energy values for use in evaluating benefits to the Susitna project. Thermal power plant construction cost data for the region and for the western states region will be reviewed. Probable plant locations will be established and general site problems will be identified. Present and pending air and water pollution standards for thermal power plants will be reviewed; the design of all plants considered will include equipment and other features necessary to meet these standards. Pending legislation which will require reclamation of strip-mined land will also be considered, and in the case of coal fired plants, will be included as a cost of mining the coal. Also, transmission facilities required to deliver power to load centers will be considered. The detail and scope of these studies will be such that power and energy cost estimates are at approximately the same confidence level as the costs to be determined for the Susitna project.

Seasonal Constraint: None

Cost: $75,000

POWER MARKET STUDIES

Activity Designation: PM-12

Activity: Assess project financial feasibility.

Description: Hydroelectric power development of the Susitna will result in hydropower production of approximately 4 times that provided in the region in 1975. The purpose of this study will be to evaluate the market for this power and to determine if the project is financially feasible. Projects are financially feasible if net revenues from power sales are sufficient to reimburse the investment. Based on load growth projections and power production and cost, the price necessary at load centers to recover investment costs with interest over a 50-year period will be determined. Saleability of power at that determined price will be investigated. Since price also influences demand for power, financial feasibility will be determined for various scenarios of load growth and interest rates. The taxing and bonding authorities of the State will be examined, and recommendations for any modifications required to implement the plan will be formulated; also, the State's present and probable future financial condition will be explored as it relates to the financing of the project by the State.

Seasonal Constraint: None

Cost: $30,000

POWER MARKET STUDIES

Activity Designation: PM-13

Activity: Prepare material for draft FERC License.

Description: If the project is built as a State-owned resource, an FERC License will probably be required (unless the specific project legislation exempts it). A Preliminary Permit application is sometimes filed prior to the detailed planning study to indicate interest in the site and reserve rights for development. This may not be required for Susitna. In any case, a license will be required prior to construction. Most of the technical data for the Preliminary Permit application is already available, and most of the technical data for the license application will be prepared as a part of the main study effort. Work under this activity will consist mainly of consolidating the data, presenting it in the required format, and providing the legal and technical support necessary to carry the application through the various hearings and other proceedings. The Susitna project is enough of a special case that a legal review should be conducted early to determine with certainty whether FPC will have jurisdiction.

Seasonal Constraint: None

Cost: $150,000, but will vary depending on the complexity of the hearings.

FOUNDATIONS AND MATERIALS (FM)

THESE ACTIVITIES INVOLVE FIELD WORK TO ASSESS GEOLOGIC AND SOIL CONDITIONS IN THE PROJECT AREA, AND DESIGN ACTIVITIES RELATED TO ALL ASPECTS OF FOUNDATION DESIGN. AN EXTENSIVE PROGRAM OF FIELD RECONNAISSANCE, DRILLING, MATERIALS TESTING, AND SEISMIC MONITORING IS OUTLINED. BASED ON THE DATA THUS COLLECTED, SITE CONDITIONS ARE EVALUATED, OPTIMAL DAM TYPES ARE DETERMINED, AND DAM COMPONENTS ARE DESIGNED. ADDITIONALLY, PARALLEL ACTIVITIES ARE CONDUCTED FOR THE ACCESS ROAD AND TRANSMISSION LINE.

REGIONAL GEOLOGY.

1. Conduct regional geology study, fault study, and seismicity evaluation.

SEISMIC MONITORING.

2. Install seismic monitoring system.
3. Operate seismic monitoring system and analyze data.

ACCESS ROAD.

4. Select route.
5. Conduct site geology and soils study.
6. Explore and test for access road.

TRANSMISSION LINE.

7. Select route.
8. Conduct site geology and soils study.
9. Explore and test.
10. Conduct foundation and materials design.

WATANA SITE.

11. Conduct site geology study.
12. Explore and test for site selection.
13. Explore for potential construction materials sources.
14. Evaluate site selection and dam.
15. Explore and test for final design.
16. Conduct geophysical investigations.
17. Perform concrete studies.
18. Perform feature design for embankment dam, cofferdams and diversions. (F&M aspects).
19. Perform feature design for spillway, powerhouse and outlet works (F&M aspects).

FOUNDATIONS AND MATERIALS (cont.)

DEVIL CANYON SITE.

20. Conduct site geology study.
21. Explore and test for site selection.
22. Evaluate for site selection and dam type.
23. Study rock mechanics and conduct in-situ testing.
24. Conduct concrete aggregate studies.

OTHER SITES.

25. Conduct field reconnaissance.
26. Explore and test for site selection and dam type.

FOUNDATIONS AND MATERIALS

Activity Designation: FM-1

Activity: Conduct regional geology study, fault study and seismicity evaluation.

Description: An extensive field reconnaissance of the Susitna area is necessary to provide information basic to site selection, dam design and the environmental impact statement supplement. Regionally, rock formations will be mapped, their boundaries determined, and their geologic structure noted. At the same time, potentially economic mineral deposits within the project area will be identified and mapped. Field data developed will be supplemented by geochemical analyses, satellite image interpretation, and possibly aeromagnetic interpretation and gravity studies.

The project is located within a tectonically active region. More information is necessary concerning the activity of known faults and the existence of other faults, if any, and their significance in relation to the project. This study will determine the location of faults throughout the region and determine those which have been active in the geologic past or which may be potentially active during the life of the project. It will develop motion parameters for both sites. Published and unpublished geologic and geophysical work done in the region will be collected and evaluated. Field and office studies then will be made, to relate the regional geology and tectonics to the known seismicity of the region. Special regional geophysical surveys will be used to help compile and understand the tectonic picture. At this stage, evaluation of seismicity will be based on existing seismic data plus evaluation of field data for evidence of recent faulting. No trenching across fault zones is anticipated at this stage, although such trenching may ultimately be required. Work will further include field mapping and checking the tectonic map developed in previous office studies. The field check will be sufficiently complete to include geomorphic evidence of recent fault activity. Geologic maps of the reservoir will be prepared to identify potential areas of land instability in the reservoirs and adjacent areas.

Seasonal Constraint: Field activity will be limited to the snow-free summer months.

Cost: $470,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-2

Activity: Install seismic monitoring system.

Description: Purpose of this activity is to establish a seismic monitoring system in the region around the sites to determine level and location of present seismicity. This will provide data to more appropriately evaluate the seismic risk for engineering structures in the area and provide a base for future determination of reservoir-induced seismicity. The system will consist of eight vertical component stations with radio telemetry, including required repeaters, to a central recording facility; and a three-component strong motion station at each damsite. Each vertical station will have a recording tiltmeter installed, with data telemetered to the central recording site.

Seasonal Constraint: Station site location should be completed by the fall of the first year so that the system design equipment acquisition and radio frequency assignment can be completed and tested during the winter period. Installation and in-place testing of the system can then be completed the following summer.

Cost: $310,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-3

Activity: Operate seismic monitoring system and analyse data.

Description: Data from the seismic monitoring system installed under activity FM-2 will be collected, analysed, and recorded throughout the construction period, as well as the operational life of the dam. To assist in the evaluation of this data in relation to reservoir-induced seismicity, it is important to establish a preconstruction record. This activity represents the effort and cost of data collection and analysis for the 3-1/2 year study period. It also includes the cost of summer visits to the instrument sites for maintenance.

Seasonal Constraint: Visits to the sites for maintenance should be accomplished between May and September of each year.

Cost: $225,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-4

Activity: Select route for access road.

Description: A field reconnaissance of the alternative access routes selected for further study under early stages of activity D-29 will be conducted by Design Branch. During this reconnaissance a Foundation and Materials representative will accompany the Design Branch team. His function will be to examine foundation conditions enroute, evaluate potential material sources, and determine exploration requirements along the alignment and at proposed bridge sites. Photographs will be taken for office use, and preliminary samples will be obtained where possible.

Seasonal Constraint: Field reconnaissance of access routes must be made during the summer or fall when foundations can be evaluated in areas of high water tables and potential permafrost zones.

Cost: $18,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-5

Activity: Conduct site geology and soils study - access road.

Description: The purpose of this activity is to map both geology and soils conditions along approximately 64 miles of potential access road. The work will consist of mapping in sufficient detail to determine rock and soil types, geologic boundaries, joint and bedding orientations, location of structural weaknesses in the rock such as folds, faults and shear zones, landslides, rock-slides, or any other geologic features which would affect design and construction of the access road. Similar investigations will be made for the several bridges required.

Seasonal Constraint: Field work limited to the period from June to September, inclusive.

Cost: $370,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-6

Activity: Explore and test for access road.

Description: The purpose of this activity is to explore subsurface conditions along approximately 65 miles of access road. Terrain varies along the route, from flat wetlands to rugged rock slopes, and a variety of exploratory procedures will be required. In the marshy areas rotary drill holes will be used to establish depth and quality of the overburden materials and the existence and extent of permafrost. Standard penetration tests will be performed and samples will be taken to enable settlement under load to be evaluated. Core borings will be used to establish the quality of bedrock, and to establish foundation grades for bridges and rock cuts. Test pits will be utilized to explore borrow sources and to examine in-place foundation materials in critical areas. This activity also includes the effort and cost associated with the necessary rock and soil sampling and testing required.

Seasonal Constraint: Exploratory work will be limited to the period from April to October.

Cost: $1,460,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-7

Activity: Select route - transmission line

Description: As a part of activity D-22, a field reconnaissance will be made to examine all transmission route alternatives resulting from studies of maps and aerial photos. A Foundations and Materials Branch representative will accompany the team to evaluate the foundation conditions, determine exploration requirements and assess slope stabilities along the routes. Preliminary samples will be taken, as well as photographs for office use.

Seasonal Constraint: Field reconnaissance of transmission routes must be made during the summer or fall season when high water tables and permafrost area can be evaluated.

Cost: $35,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-8

Activity: Conduct site geology and soils study - transmission line.

Description: Following the selection of a transmission line route and the provision of controlled topography, this activity will be initiated concurrently with FM-9 and FM-10. Geotechnical engineers in the field will cover the route, mapping the geology, studying soil conditions, planning the exploratory program, recording the exploration results, and collecting the required samples for testing. After completion of this field work, which will be done during the summer months, office studies will analyze the data collected, and the foundation design of the towers will be determined for the varying conditions defined along the route.

Seasonal Constraint: Field work will be limited to the June to September period for much of the route.

Cost: $185,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-9

Activity: Explore and test - transmission line.

Description: As a part of the field study along the transmission line, exploratory work of various kinds will be necessary to determine the various foundation conditions to be encountered and to provide the required data for appropriate design of the tower foundations. Exploration activities will entail drilling auger holes in the flatland areas where materials are principally glacial and alluvial deposits, and core drilling at critical tower sites in the mountainous areas where bedrock is exposed or close to the surface. Samples will be taken and material tests will be made to provide design information. There is no intent under this activity to completely explore the line with exploratory holes at each tower site but rather to provide information on typical reaches, sufficient for basic design and required cost estimates. It is recognized, however, that the proposed route will cover more than 350 miles of varying terrain and that access to some necessary exploration sites will be difficult and costly.

Seasonal Constraint: The field work season will be limited over much of the area to the months of June to September.

Cost: $830,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-10

Activity: Conduct foundation and materials design - transmission line.

Description: This activity covers the concrete design effort for typical tower foundations for the various types of terrain to be crossed. As a part of activity FM-9, samples of aggregate sources will be collected. The cost of testing these samples for durability and suitability for use in foundation concrete is included in this activity.

Seasonal Constraints: None

Cost: $80,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-11

Activity: Conduct site geology study - Watana

Description: A detailed geologic study of the Watana damsite area will be made, beginning in the first summer of the study period. Fractures, joint patterns and faults will be studied in detail, and this surface data will provide direction to the subsurface exploration program. As subsurface data is obtained, three-dimensional relationships will be developed, fractures and/or fault planes defined, and optimum dam locations determined. Subsequent to site selection the geology study will move into the area of specific features. Precise rock lines, depth of weathered rock, limits of foundation excavation and grouting requirements will be determined. Rock quality and structural attitudes of bedding planes will be assessed for underground features and tunnels, and requirements for rock bolting, support bents and concrete linings will be evaluated. The geology of the right abutment terrace will be closely examined to assess the deep deposits revealed by previous geophysical explorations. Permeabilities will be examined. The existence and extent of permafrost will be defined.

Seasonal Constraints: Field work, which amounts to approximately 60 percent of the effort for this activity, will be limited to the period from June to September inclusive.

Cost: Included in activities FM-12 through 16

FOUNDATIONS AND MATERIALS

Activity Designation: FM-12

Activity: Explore and test for site selection - Watana

Description: Conduct sufficient geologic mapping and subsurface exploration to permit evaluation of site, select location and type of dam, and locate appurtenant structures. It is assumed that the dam will be located near the present site between Deadman and Tsusena Creeks. Work will include preliminary mapping at the site, core drilling, air rotary drilling and bulldozer work to make trenches and drill site access roads. Air rotary drilling will be done on the right abutment terrace and will provide information on the suitability of the overburden material for borrow as well as foundation information. Air rotary drilling will also be performed in the valley alluvium upstream and downstream to check extent and suitability.

Seasonal Constraint: Field work limited to 4 summer months.

Cost: $210,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-13

Activity: Borrow exploration and testing - Watana

Description: An earth/rockfill dam at the Watana site will require in excess of 50 million cubic yards of embankment materials. Under this activity all potential sources within reasonable haul distances will be located and explored for quality, using air rotary and churn drill holes for glacial and alluvial deposits and core borings for rock quarry sites. Samples will be taken from these borings as well as from test pits and bucket auger drill holes. These samples will be tested for quality and suitability as construction materials. Particular attention will be directed toward material shear strengths under high confining pressures and toward response to dynamic cyclic loading, which relates to material response to seismic shaking. During the winter months the test data will be collected and organized into a convenient format for use by soils design engineers. Certain test results, e.g. gradation analyses and permeability test results, will be combined to form envelopes indicative of available materials. Quantities of materials represented will be tabulated, and locations of explorations permanently recorded on borrow area maps. Completion of this activity will provide embankment designers with the quantity and quality parameters to be used in developing a detailed dam design.

Seasonal Constraints: Field work will be done in the June to September periods.

Cost: $845,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-14

Activity: Evaluate site selection and dam - Watana

Description: The data obtained under activity FM-12 will provide sufficient detail relative to foundation structure and quality to permit selection of the specific damsite. The information will also be used with other relevant data to select the type of dam, i.e. earth fill or concrete gravity. The location of appurtenant structures will be determined, and the exploration program for detailed dam design will be developed. Sufficient design work is required at this time to make the necessary cost estimates required in this decision-making activity.

Seasonal Constraints: None

Cost: $170,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-15

Activity: Explore and test for final design - Watana

Description: Under this activity, explorations at the Watana damsite will be continued to fully define the rock structure and to expose fracture patterns and any minor faulting in the foundation for the main dam as well as other individual dam features. Core borings will be utilized extensively for this phase of the activity. At the higher elevations, including the deep deposits behind the right abutment, rotary drill holes, Becker drill holes, bucket auger holes, backhoe pits, and dozer trenches will be used to expose in-place materials for examination and to obtain samples for testing. If necessary, vertical shafts will also be sunk at selected sites to study in-place permeabilities and soil temperatures. During the winter months data collected will be evaluated and organized for design use as described under activities FM-18 and 19.

Seasonal Constraint: Field work will be restricted to the months of June to September inclusive.

Cost: $1,820,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-16

Activity: Conduct geophysical investigations - Watana

Description: This activity will study the presence, depth, and configuration of certain underground formations, using ground-level explosive charges which generate vibrations that strike formations of differing densities and are reflected back to ground-level sensors (a refraction seismic survey). The purpose is to obtain information about buried channels in glacial deposits on the left bank between the site and the margin of the outer valley.

Seasonal Constraint: June-August

Cost: $93,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-17

Activity: Perform concrete studies - Watana

Description: Possible sources of concrete aggregate will be located. Each source will be sampled and tested to determine the suitability of the source. The most economical source of concrete aggregate for each structure will be determined, to provide for a concrete gravity dam alternative and appurtenant structures for both an earth rock-fill dam and a concrete dam. Preliminary mix designs will be completed to provide information on cement requirements. Thermal studies will be undertaken to determine cooling requirements for mass concrete. Sources of pozzolan will be investigated. Pozzolan is finely-ground material which may be used as a replacement for a portion of the cement in mass concrete, thereby reducing costs.

Seasonal Constraint: Field reconnaissance and sampling will be accomplished during the summer construction season.

Cost: $265,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-18

Activity: Perform feature design for embankment dam, cofferdams, and diversion - Watana

Description: Under this activity, embankments will be designed to a degree consistent with the preparation of required cost estimates. Internal zoning and shape of the main dam embankment will be determined. The zoning will be somewhat dependent upon the quality of the foundation and abutments, the dam height selected and the quality and quantity of available construction materials, particularly the availability of fine-grained core material. Quality of materials will be a critical factor, and such characteristics as shear strengths under high confining pressures, permeabilities under high head, liquefaction potential, and settlement characteristics will be closely examined. Foundation permeabilities and fracture patterns will be evaluated, and the results of seismic and stability analyses reviewed. Consolidation and settlement studies will be undertaken, including a test fill if necessary to preclude internal fracturing in critical areas. Severe weather and icing conditions will be studied, and the data collected will be considered in design. A Board of Consultants of 3 to 5 members will be appointed to review the overall project scope, the geology, site selection, seismicity, and proposed specific design features. Board members selected will be geotechnical experts in the fields of geology, seismology, soil mechanics and structures. From time to time engineers with expertise in other disciplines may be included. Meetings will be held annually, and approximately three such meetings will be required during the design stage. This activity includes the cost of a complete seismicity study including determination of the design earthquake and a dynamic soils response analysis for the embankment.

Seasonal Constraint: None

Cost: $910,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-19

Activity: Perform feature design for spillway, powerhouse, and outlet works - Watana

Description: Design of the underground features of the dam including diversion tunnels, draft tubes, and penstock tubes will require careful analysis of core borings drilled under activity FM-15. As rock cores are examined, rock quality and structure will be determined. Down-hole television cameras will be used in critical areas to determine attitude of structural features and the degree of support required for each facility. Concrete linings, steel bents, rock bolt systems, and mesh reinforced shotcrete will be considered and designed as necessary. Rock permeabilities will be determined and grout curtains designed.

Seasonal Constraint: None

Cost: $410,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-20

Activity: Conduct site geology study - Devil Canyon.

Description: Geologic mapping of Devil Canyon damsite was done in 1957 by Mr. Kachadoorian of the U.S. Geological Survey. This work, supplemented by the exploratory data obtained by the Bureau of Reclamation in 1957-58, is considered sufficient for the present study with the exception of the right abutment where no exploratory drilling has been done and of the river channel itself where there is a need to define the rock line in the river and to insure that no serious faulting exists in this critical area. As these necessary explorations proceed, three-dimensional relationships of shear zones and faults in the right abutment will be established, and their relationship to the theoretical shearing plane of the arch thrust in the abutment will be examined. If necessary an adit, or access tunnel, below the river will be used to examine the foundation for structure, rock quality and permeability.

Seasonal Constraint: Field work will be restricted to the June through September season.

Cost: $35,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-21

Activity: Explore and test for site selection - Devil Canyon

Description: As outlined under activity FM-20, a need exists for core borings in the right abutment at Devil Canyon damsite to ensure structural adequacy of the supporting bedrock. An adit is also desirable beneath the channel invert (floor) to eliminate the possibility of faulting in this critical location.

Seasonal Constraint: Core drilling must be done during the frost-free season of June to September.

Cost: $650,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-22

Activity: Evaluate for site selection and type of dam - Devil Canyon

Description: The purpose of this activity is to evaluate the foundation conditions and adjust the position and/or configuration of the various structures to obtain optimum benefit with existing conditions. Work involved would include additional exploration and testing.

Cost: Included in activity FM-20 and 21.

FOUNDATIONS AND MATERIALS

Activity Designation: FM-23

Activity: Study rock and conduct in-situ testing - Devil Canyon.

Description: The purpose of this activity would be to evaluate the in-situ rock condition in the abutments of the main concrete structures and in the underground powerhouse structure. The testing required would include plate jacking tests in the exploratory adit. Other in-situ tests in boreholes in the damsite area may be deemed necessary after evaluation of preliminary core drilling.

Seasonal Constraint: Field work would be done during April - October period.

Cost: $280,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-24

Activity: Investigate concrete aggregate - Devil Canyon.

Description: Exploration of the Cheechako Creek aggregate source will be undertaken to determine the quality of material available. A large composite bulk sample will be retreived and forwarded to Troutdale, Oregon, for aggregate suitability tests and preliminary mix designs. The remainder of this aggregate will be retained for detailed design studies. In the unlikely event that the Cheekchako Creek source is inadequate in quantity or quality, additional sources will be investigated.

Seasonal Constraint: All field activities will be accomplished during the summer construction season.

Cost: $85,000

Activity Designation: FM-25

Activity: Field reconnaissance - other sites.

Description: Field reconnaissance will be required to establish foundation suitability and material availability for any damsites considered under preliminary screening, with the exception of Devil Canyon, Watana, Vee and Denali where the required information is already at hand. The field studies will examine rock structure and quality, and the existence of any limiting factors as to heights and types of structures suitable to the site. The need for subsurface data will be considered and necessary explorations planned and located. Material sources will be obtained and preliminary samples obtained.

Seasonal Constraint: Field activity will be restricted to the June through September season.

Cost: $8,000

FOUNDATIONS AND MATERIALS

Activity Designation: FM-26

Activity: Explore and test for site selection and type of dam - other damsites.

Description: Work performed under this activity will be the minimum necessary to provide foundation data demonstrating foundation suitability for purpose of preliminary screening. This information is already at hand for Devil Canyon, Watana, Vee and Denali. For other sites considered, explorations prior to screening will be limited to hand-dug test pits for embankment material and concrete aggregate sources during site reconnaissance. Samples of foundation rock will be obtained from the canyon walls. Testing will be limited to those tests necessary to confirm rock quality and to assure suitability of embankment materials and concrete aggregates.

Seasonal Constraint: Field work will be limited to the June through September seasons.

Cost: $6,000

DESIGN (D)

THIS CATEGORY COMPRISES THE ACTIVITIES ASSOCIATED WITH THE PROJECT'S STRUCTURAL COMPONENTS. INITIAL ACTIVITIES PROVIDE THE CONCEPTUAL DESIGNS FOR PRELIMINARY SCREENING OF COMPETING ALTERNATIVES. MORE DETAILED DESIGN WORK IS THEN ACCOMPLISHED ON THE SELECTED PLAN FOR PURPOSES OF DETAILED FEASIBILITY ANALYSIS AND OF DETAILED DESIGN FOR THE PLAN'S INITIAL PHASE OF DEVELOPMENT.

PRELIMINARY SCREENING.

1. Make preliminary selection of potential damsites.
2. Conduct site inspection.
3. Determine types and heights of dams.
4. Determine powerhouse size and location.
5. Develop diversion scheme.
6. Develop water passages.
7. Estimate project costs.

DETAILED FEASIBILITY STUDIES (WATANA AND DEVIL CANYON).

8. Study dam type and height.
9. Study spillways.
10. Study outlet works.
11. Study water diversion and care.
12. Study powerhouse size, type and location.
13. Study power intake and conduit.
14. Estimate selected project cost.

DETAILED DAM ANALYSIS (WATANA SITE).

15. Study dam type and height.
16. Study spillways.
17. Study outlet works.
18. Study water diversion and care.
19. Study powerhouse size, type and location.
20. Study power intake and conduit.
21. Estimate selected project cost.

TRANSMISSION FACILITIES.

22. Conduct route studies.
23. Conduct transmission system study.
24. Conduct tower, hardware, and conductor studies.
25. Conduct foundation type studies.
26. Conduct substation studies.
27. Conduct switchyard studies.
28. Estimate transmission facilities cost.

ACCESS ROADS.

29. Conduct route studies.
30. Conduct bridge studies.
31. Estimate selected route costs.

RESERVOIR CLEARING.

32. Conduct field survey.
33. Conduct marketability and disposal study.
34. Estimate clearing costs.

CONSTRUCTION AND PERMANENT CAMP FACILITIES.

35. Determine requirements.
36. Study locations and layouts.
37. Estimate camp costs.

OTHER HYDRAULIC CONSIDERATIONS.

38. Study upstream and downstream effects.
39. Determine model studies to consider.

DESIGN

Activity Designation: D-1

Activity: Make preliminary selection of potential damsites.

Description: A map and aerial photo study will be made of potential damsites within the Upper Susitna Basin. For those damsites which appear to be feasible, an analysis of pool elevation will be made to determine optimum pool elevation for the particular site. A determination of dam type best suited for the site will be made in conjunction with personnel from the Foundations and Materials Branch. This activity would be a part of the reformulation studies required to verify or supplement the existing feasibility study. The analysis will cover the various dam locations, layouts, and pool heights investigated with a recommendation for those sites to be investigated during the preliminary screening phase.

Seasonal Constraint: None

Cost: $12,000

DESIGN

Activity Designation: D-2

Activity: Conduct site inspection.

Description: Some of the sites in activity D-1 will require on-site inspection to verify or expand information from the map and aerial photo studies. Inspections will provide field data required for recommendation or rejection of a site, and will be made in conjunction with personnel from the soils and materials branch to determine whether or not a site appears to be suitable for construction.

Seasonal Constraint: Would be made during summer.

Cost: $28,000

DESIGN

Activity Designation: D-3

Activity: Determine types and heights of dams.

Description: The feasible sites will be further explored during this activity to develop a recommended type of dam and a most economical height for each site. Different combinations of dams will be considered at this stage. At this point a determination will be made whether the site is most suitable for a concrete gravity dam, gravity arch, arch, earthfill, rockfill, etc. During this period there may be a requirement for a site visit to some sites. The selection of dam type and height will be a multi-discipline determination with input from various sections and branches. The selected type will then be further studied to determine the shape, layout, preliminary stability, etc., in sufficient detail to allow a cost estimate to be made as a basis for recommendation of the selected plan to be developed in detailed feasibility studies.

Seasonal Constraint: Would require some field investigation in summer.

Cost: $34,000

DESIGN

Activity Designation: D-4

Activity: Determine powerhouse size and location.

Description: This activity will size and locate powerhouses at the preliminary damsites to be investigated during the screening process. Studies will be in sufficient detail to allow a cost estimate to be prepared which will in turn support a recommendation for the selected project to be investigated during detailed feasibility studies.

Seasonal Constraint: None

Cost: $25,000

DESIGN

Activity Designation: D-5

Activity: Develop diversion scheme.

Description: A scheme for river diversion during construction will be developed for each damsite under consideration. This activity will study each site to determine which type of scheme would be most suitable for the particular site. The following types of diversions would be considered: tunneling, diversion through a low section of dam, diverting the river via a coffer-dam and building one side of the dam. Preliminary detail will be developed to allow an estimate for recommending a selected plan to be further developed during detailed feasibility studies.

Seasonal Constraint: None

Cost: $25,000

DESIGN

Activity Designation: D-6

Activity: Develop water passages.

Description: This will be a study to determine the type, location, number and size of spillways, sluices, outlet works and water quality conduits. These items must be sized and located to minimize adverse impact on water quality and erosion downstream of the dams. This study will also address the type of gate required for each water passage. Preliminary detail will be prepared for a cost estimate to serve as a basis of recommending a selected plan for further study during detailed feasibility studies.

Seasonal Constraint: None

Cost: $40,000

DESIGN

Activity Designation: D-7

Activity: Estimate project costs.

Description: This activity will be a construction estimate (including contingencies) of all the features of each dam considered under the preliminary dam selection. The estimate must be in sufficient detail to allow a clear-cut decision to be made on what system of dams to recommend for further study in detailed feasibility studies.

Seasonal Constraint: None

Cost: $17,000

DESIGN

Activity Designation: D-8

Activity: Study dam type and height.

Description: This activity will consist of planning studies and preliminary design of dams at Devil Canyon and Watana as the assumed dams that will be studied in detail for feasibility. Devil Canyon will be investigated as a concrete arch. A brief investigation of a concrete gravity section will be made at Watana to reconfirm the selection of an embankment section. These studies will be of sufficient scope to allow completion of a detailed feasibility analysis.

Seasonal Constraint: None

Cost: $90,000

DESIGN

Activity Designation: D-9

Activity: Study spillways.

Description: This activity will be a hydraulic and structural study of alternative spillway designs for Devil Canyon and Watana dams. Spillway geometry, gates, piers, walls, energy dissipater, etc., will be sized for estimating and selection of a recommended scheme. The recommended schemes will be further studied to develop detailed hydraulic design and to allow preparation of preliminary design drawings, including layout, plans, elevations and sections, and monolith stability. (See activity D-16.) Preliminary design of bridges, piers, gates, stoplogs, and hoists will be done. Design will be sufficient for completion of a detailed feasibility analysis.

Seasonal Constraint: None

Cost: $68,000

DESIGN

Activity Designation: D-10

Activity: Study outlet works.

Description: This activity will be a hydraulic and structural study of alternative outlet works designs for Devil Canyon and Watana dams. Intakes, gates, bulkheads, sluices, tunnels, air vent, energy dissipater, etc., will be sized and estimated to arrive at a selected scheme. Preliminary design drawings will be prepared to include layout, plans, elevations, and sections. Tower section stability will be checked. Preliminary design of tower, gates, bulkheads, trashracks and outlet structure will be prepared. This design will be adequate for a detailed feasibility study. (See activity D-17 for detailed studies for Watana.)

Seasonal Constraint: None

Cost: $66,000

DESIGN

Activity Designation: D-11

Activity: Study water diversion and care.

Description: This activity will make hydraulic and structural studies of river diversions using tunnels, cofferdams, tailrace tunnels, etc. It will include preliminary design of selected scheme including closure methods, structure size, channels, tunnel, etc. The design will be adequate for a detailed feasibility study. (See activity D-18 for detailed studies for Watana.)

Seasonal Constraint: None

Cost: $62,000

DESIGN

Activity Designation: D-12

Activity: Study powerhouse size, type, and location.

Description: This activity will look at Devil Canyon and Watana dams with reference to powerhouse layout and arrangement, powerhouse type, turbine studies and tailrace studies. Tailrace studies will determine size, setting, type, lining, tunnel length, surge tank size and location, closure structures and bulkhead handling. Turbine studies will look at type selection, size, setting and number of units. Powerhouse type selection will involve comparative studies of above- and below-ground locations. A preliminary cost estimate will be prepared. The design studies will be of sufficient detail for a detailed feasibility study.

Seasonal Constraint: None

Cost: $100,000

DESIGN

Activity Designation: D-13

Activity: Study power intake and conduit.

Description: This activity will investigate the power intake and conduits for Devil Canyon and Watana dams. The study will include the penstocks from power intake structure to the gates or valves, upstream of the powerhouse, the intake structure and bridge, selective withdrawal system, power bellmouths and emergency gates. This study will arrive at a recommended design, and be of sufficient detail to allow a preliminary cost estimate for a detailed feasibility study.

Seasonal Constraint: None

Cost: $200,000

DESIGN

Activity Designation: D-14

Activity: Estimate selected project cost.

Description: This activity will provide a preliminary cost estimate of the selected plan for Devil Canyon and Watana dams based on preliminary designs and studies outlined in previous activities (D-8 thru D-13).

Seasonal Constraint: None

Cost: $16,000

DESIGN

Activity Designation: D-15

Activity: Study dam type and height (Watana)

Description: This study assumes that Watana will be an embankment dam. A brief investigation will be made of a concrete gravity dam to reconfirm that an embankment dam is the best alternative at this site. The remainder of design efforts will be in conjunction with F&M design of the embankment dam. Should the concrete dam study show it to be the best alternative, then the design funds for the embankment dam would be transferred to study the concrete one.

Seasonal Constraint: None

Cost: $50,000

DESIGN

Activity Designation: D-16

Activity: Study spillway. (Watana)

Description: This activity will provide a detailed hydraulic and structural design study of alternative spillway designs. Spillway geometry, gates, piers, walls, energy dissipater, etc., will be selected and sized for cost estimating purposes. The scheme will be further studied to develop detailed hydraulic design and to allow preparation of preliminary design drawings, including lay-out, plans, elevations and sections, and monolith stability. Preliminary design of bridges, piers, gates, stoplogs, and hoists, etc., will be done with a detailed cost estimate. Model studies will be required to verify design.

Seasonal Constraint: None

Cost: $406,000

DESIGN

Activity Designation: D-17

Activity: Study outlet works. (Watana)

Description: This activity will provide a hydraulic and structural detailed design of alternative outlet works. Intakes, gates, bulkheads, sluices, tunnels, air vent, energy dissipater, etc., will be selected and sized. The scheme will be developed to provide a refined hydraulic and structural design. Preliminary design drawings will be prepared to include layout, plans, elevations, and sections. Tower section stability will be checked. Preliminary design of tower, gates, bulkheads, trashracks and outlet structure will be prepared to provide a detailed cost estimate. The selected hydraulic design will be modeled to verify the design.

Seasonal Constraint: None

Cost: $498,000

DESIGN

Activity Designation: D-18

Activity: Study water diversion and care. (Watana)

Description: This activity will make hydraulic and structural detailed-design studies of river diversions using tunnels, cofferdams, tailrace tunnels, etc. It will include hydraulic design of the selected scheme including closure methods, structure size, channels, tunnel, etc. Sufficient detail will be developed to allow a detailed cost estimate to be made. A hydraulic model study will be made to verify hydraulic design.

Seasonal Constraint: None

Cost: $393,000

DESIGN

Activity Designation: D-19

Activity: Study powerhouse size, type, and location. (Watana)

Description: Detailed studies will look at powerhouse layout and arrangement, powerhouse type, turbine studies and tailrace studies. Tailrace studies will determine size, setting, type, lining, tunnel length, surge tank size and location, closure structures and bulkhead handling. Turbine studies will look at type selection, size, setting and number of units. Powerhouse type selection will involve comparative studies of aboveground and underground locations. A detailed cost estimate will be prepared.

Seasonal Constraint: None

Cost: $200,000

DESIGN

Activity Designation: D-20

Activity: Study power intake and conduit. (Watana)

Description: This activity will extend findings of hydropower study for designing conduits and penstocks. It will include the power conduits and penstocks from power intake structure to the gates or valves, upstream of the powerhouse, the intake structure and bridge, selective withdrawal system, power bellmouths, and emergency gates. This study will be quite extensive because of the high dam under consideration. The study will arrive at a design of sufficient scope for a detailed cost estimate.

Seasonal Constraint: None

Cost: $720,000

DESIGN

Activity Designation: D-21

Activity: Estimate selected project cost. (Watana)

Description: This activity will provide a detailed cost estimate of the selected plan for Watana Dam based on detailed designs and studies outlined in activities D-15 through D-20.

Seasonal Constraint: None

Cost: $18,000

DESIGN

Activity Designation: D-22

Activity: Conduct route surveys.

Description: The transmission corridors are somewhat set by existing facilities and terrain features. Map and aerial photo studies will be made to narrow down the routes. Then a field reconnaissance by civil, structural, materials, and electrical engineers will be made to define problem areas. Clearing studies will be required, as well as a study of possible markets for timber. The selected route would have a road parallel to, and as close as possible to the line to minimize construction costs. Close attention will be given to possible areas of high wind, rime ice buildup, and drifting or creeping snow. Some areas of the corridor may require fitting the lines into a narrow canyon already having a river, highway and railroad. Route selection will have to include consideration of tower location, conductor slope, dangerous trees, foundation locations and maintenance access.

Seasonal Constraint: Field work would be completed over 2 summers.

Cost: $250,000

DESIGN

Activity Designation: D-23

Activity: Conduct transmission system study.

Description: This study will be to reconfirm the type of transmission system running from the dams to both Fairbanks and Anchorage. The study will consider the location of project headquarters, remote operation, dispatch centers, operation and maintenance, line voltage, number of lines, and circuitry. A direct current system would be evaluated at some point in the study.

Seasonal Constraint: None

Cost: $36,000

DESIGN

Activity Designation: D-24

Activity: Conduct tower, hardware, and conductor studies.

Description: Present planning calls for lines of different capacity to Fairbanks and Anchorage. When the route is fairly well located, a study of towers, hardware, and conductor can be made. Depending on route location, there could be a change in tower type, as the line will traverse different types of terrain. Conductor type is dependent upon tower spacing and loads. At the beginning of this study, the loads would be the first item to be determined. Such things as design wind, snow, icing, span factor, etc., would be determined. Towers to be considered would be self-support or guyed and probably steel or aluminum. Coloration of the metal will be considered to develop a scheme which is aesthetically acceptable. The color treatment might vary depending on the area being traversed. Hardware would be compatible with the towers and conductor.

Seasonal Constraint: Some site visits in summer.

Cost: $55,000

DESIGN

Activity Designation: D-25

Activity: Conduct foundation-type studies.

Description: This will involve a study of various types of footings for the various towers and the different types of foundation material that will be encountered. Close coordination will be maintained with foundations personnel during this study. Some areas may be in permafrost, some on rock, some on gravel and others in muddy or boggy areas. This study will be made almost simultaneously with D-24. In some areas consideration may be given to using a precast foundation carried to the site by helicopter or truck.

Seasonal Constraint: Site visits in summer or fall.

Cost: $30,000

DESIGN

Activity Designation: D-26

Activity: Conduct substation studies.

Description: This will determine requirements for substations, their location, and general layout. It will include the investigation of location for substations at all line terminations including expected future expansion. It might involve some research into special items for cold weather. Field verification of locations would be made. Preliminary studies would look at economical and operational advantages of various bus schemes and breaker arrangement for each installation. Number of circuit breakers and ratings of power transformers will also be determined. Major equipment items such as transformers, circuit breakers, lightning arrester and switches will be included. Protective relaying, supervisory controls, telemetry, and related communication equipment for each switchyard and substation will be investigated.

Seasonal Constraint: Verification of sites in summer or fall.

Cost: $114,000

DESIGN

Activity Designation: D-27

Activity: Conduct switchyard studies.

Description: This study will consist of the locating and laying out of switchyards. This will include ties between powerhouse and switchyards as well as possible tie in at a switchyard of a line coming in from another dam. Research may be necessary into special items for cold weather. Major equipment items such as transformers, circuit breakers, lightning arrestors, and switches will be included. Protective relaying, supervisory controls, telemetry, and related communication equipment required will be investigated. This study will be made in conjunction with D-26.

Seasonal Constraint: None

Cost: $76,000

DESIGN

Activity Designation: D-28

Activity: Estimate transmission facilities cost.

Description: Initially this will involve estimating alternative routes as well as type of line construction for project feasibility. A detailed cost estimate will also be made of final located transmission line and supporting facilities.

Seasonal Constraint: None

Cost: $18,000

DESIGN

Activity Designation: D-29

Activity: Conduct route studies.

Description: This activity will select the routes for construction and permanent access to the Upper Susitna basin and selected dam sites. In the preliminary stages alternate routes will be located from both the Anchorage-Fairbanks highway and the Denali highway. Map and aerial photo reconnaissance will be made followed by field reconnaissance along alternate routes. Preliminary route selection will be followed by field verification. Final location will be an iterative process of adjusting locations and grades based on field and office meetings with personnel working on foundations and structures (bridges). Clearing requirements and disposition of merchantable and nonmerchantable timber will be determined.

Seasonal Constraint: On-site investigations will be made in the summer.

Cost: $78,000

DESIGN

Activity Designation: D-30

Activity: Conduct bridge studies.

Description: These studies will determine number and type of bridges required on the access routes to the dams. They will include temporary and permanent bridges of wood, steel, and concrete construction. The designer must work closely with the foundations people as well as the route selection personnel. Foundation design may vary from rock to permafrost. At some point in the study on-site investigations will be required of the final route location. These visits will involve all disciplines to insure that final selection is the best location and the most economical.

Seasonal Constraint: Foundations information and site investigations are restricted to period when no snow is on the ground.

Cost: $60,000

DESIGN

Activity Designation: D-31

Activity: Estimate selected route costs.

Description: This will include construction estimates of alternate routes including bridges, culverts, etc., to allow selection of a final route. A detailed cost will be prepared for the final route.

Seasonal Constraint: None

Cost: $21,000

DESIGN

Activity Designation: D-32

Activity: Conduct field survey.

Description: A study will be made of aerial photos for the reservoir area to determine areas which may require clearing. Some on site inspections will be required to verify photo studies or to obtain data not available on the photos. Sufficient information will be required to provide an estimate of clearing costs.

Seasonal Constraint: This can best be accomplished during summer.

Cost: $8,000

DESIGN

Activity Designation: D-33

Activity: Conduct marketability and disposal study.

Description: This will be a study of trees within reservoir area to determine types, size, and quantities. Market location will be determined for feasibility of marketing the trees. Disposal methods and areas will be studied to determine disposal methods that are economical and environmentally sound. Possible logging roads should be considered in this phase. Study will require some on site investigation and some soils information in any proposed burial areas.

Seasonal Constraint Best accomplished during summer.

Cost: $20,000

DESIGN

Activity Designation: D-34

Activity: Estimate clearing costs.

Description: Detailed estimate will include a study of the economics of removing timber for sale versus disposal on site. Disposal will look at burning and burying. Removal will have to consider requirements for additional roads into the reservoir area.

Seasonal Constraint: None

Cost: $8,000

DESIGN

Activity Designation: D-35

Activity: Determine camp requirements.

Description: An estimate will be made of the number of construction management personnel on site as well as the number of operations and maintenance personnel to run the project. The requirements for buildings and camp support facilities will then be developed. This will also require a determination of how construction support offices will be handled, staffed, and located. This should include a determination of whether one camp could support more than one dam site. Once these requirements have been determined the location and layout of camps can proceed. This does not include facilities for contractor personnel.

Seasonal Constraint: None

Cost: $30,000

DESIGN

Activity Designation: D-36

Activity: Study location and layouts.

Description: This will involve a selection process of picking a camp location(s) (including site visits) which will best support the scheme of construction management and project operations. It will involve siting and sizing a camp to handle the number of persons and type of activities involved. Consideration will have to be given to living accommodations, working spaces, equipment storage, and maintenance, schooling, etc. Water, sewage, garbage, lights, etc., will have to be considered.

Seasonal Constraint: Site visits will be made in summer.

Cost: $40,000

DESIGN

Activity Designation: D-37

Activity: Estimate camp costs.

Description: A detailed cost estimate of the construction camp facilities required to support construction management as well as the permanent camp facilities which will support the project operation scheme will be made.

Seasonal Constraint: None

Cost: $10,000

DESIGN

Activity Designation: D-38

Activity: Study upstream and downstream effects.

Description: This study will make a cursory investigation of the effects the various dam pools have on upstream and downstream river levels. The selected plan will require a much more detailed investigation of the effects the dams have on upstream and downstream river levels. Some of the items to be investigated are as follows: bank erosion, stream flows, flow effects on fisheries, requirements for reregulating dam, downstream flooding, etc. These studies could dictate the need for a reregulating dam, bank protection, flood plain zoning, channel excavation, and realignment.

Seasonal Constraint: Some field work would be required in summer months.

Cost: $75,000

DESIGN

Activity Designation: D-39

Activity: Determine model studies to consider.

Description: This activity would take place after the selected plan is determined. From the various areas of hydraulic concern, one would work up a list of desirable model studies which should be made prior to final design. Some of these model studies would probably be started prior to completion of detailed feasibility studies if required to assure design verification for estimate of project costs.

Seasonal Constraint: None

Cost: $4,000

REAL ESTATE (RE)

THE REAL ESTATE ACTIVITIES HAVE A TWOFOLD PURPOSE. THE FIRST IS TO DETERMINE OWNERSHIP OF LAND IN THE PROJECT AREA AND ESTABLISH LAND VALUE. THE SECOND IS TO ARRANGE FOR ENTRY TO PRIVATE LAND FOR PURPOSES OF ACCESS OR FIELD WORK.

INVESTIGATIONS AND DETERMINATIONS.

1. Conduct real estate field investigations.
2. Make real estate legal determinations.

RIGHTS OF ENTRY.

3. Obtain rights of entry for survey and exploration at dam sites.
4. Obtain rights of entry for survey and exploration along access road.
5. Obtain rights of entry for survey and exploration along transmission corridor.

REAL ESTATE

Activity Designation: RE-1

Activity: Conduct real estate field investigations.

Description: This activity will begin with an aerial inspection to familiarize real estate personnel with the physical characteristics affecting land value in the project area. Ownership information will then be gathered from records of assessors, recorders, BLM and the State Division of Lands. Interviews will be conducted with land owners and area residents to acquire knowledge of future developments, and to assemble information on opinions regarding the proposed project. From these interviews and the information developed in other studies (EC-4 through 6 and PM-2 through 4), the local area's development trends will be assessed. Comparable sales data will be collected to determine the market value of the project areas.

Seasonal Constraint: None

Cost: $7,000

REAL ESTATE

Activity Designation: RE-2

Activity: Make real estate legal determinations.

Description: Title evidence as to ownership will be secured, and the validity of interests will be determined. Also, such outstanding interests as mining claims, nature claims, easements, etc., will be researched. An investigation will be conducted and a determination made of compensible interests, if any, of the rights held by third parties in the real estate to be acquired. A compensible interest study must be written for each such interest. Also, legal research will be conducted as to the effect of the Alaska Native Claims Settlement Act, the Alaska Statehood Act, and other applicable laws on the existing power site withdrawal.

Seasonal Constraint: None

Cost: $33,000

REAL ESTATE

Activity Designation: RE-3, 4, 5

Activity: Obtain rights of entry, as necessary, prior to entry at damsites, along the access route, and along the transmission corridor.

Description: Land owners in the project area will be contacted by mail, telephone, and personal visits to obtain the proper authorization for entry in order to conduct reconnaissance and exploration. The effort involved in arranging entry to the dam and reservoir areas is relatively minor because of the power withdrawal status of the prospective dam sites and of portions of the reservoir sites. More time-consuming will be seeking permission for entry from property owners along the access and transmission routes.

Seasonal Constraint: None

Cost: $19,000

CULTURAL RESOURCES (C)

THESE ACTIVITIES OUTLINE FIELD AND LITERATURE SURVEYS TO LOCATE, MAP, AND DESCRIBE THE SIGNIFICANT ARCHEOLOGICAL AND HISTORIC SITES WITHIN THE PROJECT AREA. THE SURVEY FINDINGS ARE THEN INCORPORATED IN THE DETAILED FEASIBILITY ANALYSIS.

ARCHEOLOGICAL

1. Conduct an archeological reconnaissance.

HISTORICAL

2. Locate, map, and describe all significant historic properties within areas of project impact.

CULTURAL RESOURCES

Activity Designation: C-1

Activity: Conduct an archeological reconnaissance.

Description: This study will consist of selected field examinations of the proposed project area(s). The study will be designed to test and refine data from the Preliminary Assessment, entitled "Heritage Resources Along the Upper Susitna River," prepared by the Alaska Division of Parks in August 1975. The study will provide factors on which an intensive survey can be planned and budgeted. It will also include field examination of selected and potential prehistoric properties identified in the Preliminary Assessment. The objective here will be to determine the probable number and types of prehistoric resources within the project areas and the probable impact of the project on those resources.

At the end of the field work, a Cultural Resources Reconnaissance Report (the Cultural Resources Appendix) will be prepared which will also include data related to historic resources identified under Activity C-2. The report will estimate the number and probable distribution of sites within the project areas, and will recommend a research design and subsequent cost estimate for the program. The intensive survey will not be undertaken until after the project feasibility analysis has been completed and a decision is made regarding project construction. At that time, and prior to construction impacts, an intensive on-the-ground survey of the project area will be undertaken, under separate contract, to locate all the cultural resources within that area and to evaluate the impact of the project upon those resources. The intensive survey would still involve only minimal field testing as necessary to determine potential eligibility of sites for inclusion in the National Register.

Seasonal Constraint: Field work can be accomplished only during snow-free periods when soils are unfrozen.

Cost: $100,000

CULTURAL RESOURCES

Activity Designation: C-2

Activity: Locate, map, and describe all significant historic properties within areas of direct project impact.

Description: The purpose of this study is to identify all significant historic properties which would be impacted by the project, describe what types of impacts will occur, and recommend procedures for mitigation or preservation of such sites. Work will primarily be accomplished by searching documents related to historical aspects of the immediate project area(s), and to the specific historic properties located within project impact areas. This research will establish the settlement, construction, occupation, and related historical record of events which followed the discovery of the Susitna River by Captain James Cook in 1778. Field work related to this activity will be relatively minor, primarily consisting of search for or verification of properties described in existing documents, and will be accomplished concurrently with prehistoric survey activities described in C-1. Results of the historic properties survey will be included as appropriate in the Cultural Resources Reconnaissance Report described under C-1.

Seasonal Constraint: Field work will be subject to the same constraints as activity C-1.

Cost: $10,000

FIELD CAMP (FC)

THE TWO ACTIVITIES IN THIS CATEGORY ADDRESS THE EFFORT REQUIRED IN DESIGNING, CONSTRUCTING, AND OPERATING A CAMP AND AN AIRSTRIP IN THE PROJECT AREA DURING THE PROJECT FEASIBILITY ANALYSIS. THE FACILITIES WILL BE USED BY PEOPLE ENGAGED IN SURVEY, BIOLOGICAL, GEOLOGICAL, AND HYDROLOGICAL FIELD WORK.

FIELD CAMP

1. Design, construct, and operate field camp.

AIR FIELD

2. Design and construct airstrip.

FIELD CAMP

Activity Designation: FC-1/1a

Activity: Design, construct, and operate field camp.

Description: This activity will consist of the design, construction, and operation of a field camp for personnel required for early drilling, surveying, environmental studies, etc. Camp size and use is based on an average of 40 people in camp 180 days per year, and over a 3 year period. This estimate is based on the assumption that at the end of the 3-year use period, camp removal cost would equal salvage value. Leaving the camp in place would result in a cost saving for later project work. The camp will be of modular construction, and probably will be lifted in by Sky-crane.

Seasonal Constraint: None

Cost: $1,500,000 ($1,000,000 operations [1/]
500,000 design, purchase, and construction)

1/ Operation cost is based on an average of 40 men @ $50/day for 180 days per year for a 3 year period.

FIELD CAMP

Activity Designation: FC-2

Activity: Design and construct airstrip.

Description: This activity consists of the design and construction of a small landing strip, 100 feet by 2,000 feet, near the camp. This strip will initially be a small bush strip, with the possibility that size will be increased when construction commences. The airstrip will be used to support the field camp.

Seasonal Constraint: Construction after break-up.

Cost: $125,000

BIOLOGICAL STUDIES (B)

THESE ACTIVITIES DESCRIBE THE FIELD WORK AND IMPACT ANALYSIS ASSOCIATED WITH THE BIOLOGICAL ENVIRONMENT AFFECTED BY THE PROJECT. FIRST, THE ABUNDANCE, DISTRIBUTION, AND HABITAT REQUIREMENTS OF VARIOUS SPECIES ARE DETERMINED THROUGH FIELD SURVEYS. UTILIZING INFORMATION RELATED TO PRE- AND POST-PROJECT HYDROLOGIC CONDITIONS, THE IMPACTS ON CRITICAL HABITAT ARE IDENTIFIED AND EVALUATED. PROBABLE EFFECTS OF THE PROJECT ON PLANTS AND ANIMALS ARE IDENTIFIED. MITIGATIVE OR ENHANCEMENT MEASURES ARE DETERMINED.

VEGETATIVE COVER.

1. Obtain necessary aircraft/satellite imagery and utilize manual interpretive techniques and automatic data processing techniques to type vegetation within areas of project impact.

STUDIES OF AQUATIC ANIMAL AND PLANT LIFE.

2. Identify and determine project impacts on significant invertebrate species.

ANADROMOUS FISHERY STUDIES.

3. Determine relative abundance, distribution, migrational characteristics, and habitat requirements of anadromous fish within impacted areas, and locate and define the seasonal freshwater habitat requirements important to the successful migration, spawning, incubation, and rearing of these species.
4. Determine project effects on anadromous fish.

RESIDENT FISH STUDIES.

5. Determine relative abundance, distribution, and habitat requirements of resident fish within impacted areas, and locate habitat critical to successful spawning and rearing of these species.
6. Determine project effects on resident fish.

ESTUARINE STUDIES.

7. Identify and assess effects of altered outflow of the Susitna River upon the estuarine area in upper Cook Inlet estuary.

BIOLOGICAL STUDIES (cont.)

MOOSE STUDIES.

8. Identify and map moose habitat within impacted areas, locate critical habitat, determine habitat condition and carrying capacity, and identify water conditions associated with moose habitat.

9. Identify moose subpopulations and determine the seasonal distribution, movement patterns, size and trend of those subpopulations within areas of project impact, and determine the timing and degree of subpopulation dependency on impacted habitat.

10. Determine impact of project upon moose habitat and populations.

CARIBOU STUDIES.

11. Identify and map caribou habitat associated with alternate transmission corridors and areas subject to impoundment and determine the seasonal ranges and migration routes of caribou with emphasis on traditional migration routes with respect to the proposed impoundment areas.

12. Determine project impacts upon Nelchina caribou herd.

STUDIES OF OTHER MAMMALS.

13. Inventory the number, size, territory, and other essential activity areas and determine and evaluate probable project impacts on wolf packs which inhabit areas that will be directly impacted by the project.

14. Estimate black and brown/grizzly bear populations and distribution in the project impact area and determine and evaluate probable project impacts.

15. Determine the general abundance and distribution of wolverines in the project impact area and determine and evaluate probable project impacts.

16. Determine the relative abundance of Dall sheep inhabiting mountains adjacent to the project impact area and delineate seasonal ranges. Determine and evaluate probable project impacts.

17. Determine the relative abundance and distribution of fur bearer, small game, nongame, and bird species in the proposed impoundment areas and determine and evaluate probable project impacts.

STUDIES OF RARE AND ENDANGERED SPECIES.

18. Determine whether any rare and endangered species of plants, fish, birds, mammals, or other wildlife are present in the project area, and evaluate impacts of the proposed action on these species.

STUDIES RELATED TO ECONOMIC VALUE OF FISH AND WILDLIFE.

19. Determine annual harvest rates of species of fish and wildlife utilized for commercial and recreational purposes, and estimate changes expected as a result of the project. Determine importance of impacted species to regional populations.
20. Identify and display damages to fish and wildlife in monetary terms and determine measures required to reduce or offset damages or to enhance existing habitat.

IMPACTS OF ENERGY ALTERNATIVES.

21. Identify and describe environmental components and impacts related to each alternative identified as a possible solution to electrical energy needs.

BIOLOGICAL STUDIES

Activity Designation: B-1

Activity: Obtain necessary aircraft/satellite imagery and utilize manual interpretation and automatic data processing techniques to type vegetation within impoundment areas, downstream flood plain, and along transmission corridors.

Description: LANDSAT-1 and 2 and/or ERTS imagery will be compiled from existing depositories, or obtained by special photography requests which may be necessary to reflect seasonal variations in vegetative types. From this imagery, a vegetation map(s) will be prepared utilizing appropriate computer facilities in cooperation with the BLM Application System Verification Test. Ground truth field investigations will be required to verify computer map delineations and questionable interpretations. It is essential that the principal investigators of the biological studies work directly with the habitat mappers.

Seasonal Constraint: Limited to snow-free periods. Most work will be accomplished in seasons of vegetative growth.

Cost: $158,000

BIOLOGICAL STUDIES

Activity Designation: B-2

Activity: Identify significant aquatic invertebrate and vegetation species and determine project impacts.

Description: Significant aquatic invertebrate and vegetation species will be sampled within the impacted areas. This baseline survey will include the mainstream Susitna, its sloughs and tributaries above and below the dam. Invertebrate specimens are to be preserved and identified, and quantitative studies conducted whenever possible. Spatial and seasonal distribution and abundance are to be described for aquatic vegetation. Using this data, an evaluation will be made of the impacts the project will have on these species. Effects of changes in temperature, nutrients, suspended sediment, fluctuation and velocity, and secondary effects resulting from changes in aquatic vegetation, fish population/densities, etc., should be determined.

Seasonal Constraint: None

Cost: $127,000

BIOLOGICAL STUDIES

Activity Designation: B-3/3a

Activity: Determine relative abundance, distribution, migrational characteristics, and habitat requirements of anadromous fish within impacted areas, and locate and define the seasonal freshwater habitat requirements important to the successful migration, spawning, incubation, and rearing of these species.

Description: Investigations will be conducted in areas within the drainage that may potentially be impacted by project development. Specific studies will be designed to determine relative abundance and migrational characteristics and timing of each anadromous species during juvenile and adult life history stages, to inventory and describe the existing hydrological, physical, and limnological conditions affecting the life history stages of anadromous fish, and to determine the contribution of potentially affected stocks to the salmon production within Cook Inlet as a whole, and specifically, their contribution to the production within the Susitna River drainage. This work will be accomplished by field survey crews using mechanical and electronic gear, nets, and by aerial surveys. As critical habitat areas are identified, study emphasis will be concentrated in these locations.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $1,061,000

BIOLOGICAL STUDIES

Activity Designation: B-4

Activity: Determine and evaluate project impacts on anadromous fish.

Description: This activity will consist of determining the types and magnitude of effects which the project is likely to have upon anadromous fish. On the basis of data gathered pursuant to activity B-3, the effects of altered river flow and changes in water quality characteristics will be evaluated utilizing information obtained from other activities. These include water quality studies (physical, chemical, and biological characteristics), determination of annual and seasonal flow duration, peak and volume curves, low flow frequency analysis, average annual sediment load, water surface profiles and winter ice conditions, with and without the project, and downstream physical effects resulting from changes in flow regime.

Seasonal Constraint: None

Cost: $83,000

BIOLOGICAL STUDIES

Activity Designation: B-5/5a

Activity: Determine relative abundance, distribution, and habitat requirements of resident fish within impacted areas, and locate habitat critical to the successful migration, spawning, incubation, and rearing of these species.

Description: Data relevant to resident fish species will be coordinated with anadromous fish studies downstream from Devil Canyon. Special attention will be given those areas important to resident fish which may not coincide with anadromous fish habitat. Resident fish studies consisting of inventories of distribution and abundance will also be conducted along the Susitna River mainstem and its tributaries upstream from Devil Canyon to the mouth of the Tyone River and streams bisected by transmission corridors. Of particular importance in this study will be the determination of winter distribution and habitat requirement within areas subject to project impact. Studies will be made of the tributaries where it is suspected that resident fish predominantly reside during the summer months, and the mainstem Susitna River where many of these same fish may winter. Study of streams along transmission line corridors will be limited to those identified as having some direct impact from project construction.

The investigations and results will be reviewed annually by the professionals conducting the studies to reevaluate the potential project impacts and redefine the study direction as necessary.

Seasonal Constraint: None

Cost: $778,000

BIOLOGICAL STUDIES

Activity Designation: B-6

Activity: Determine and evaluate project impacts on resident fish.

Description: The purpose of this activity is to determine the types and magnitudes of effects which the project is likely to have on resident fish, pursuant to an evaluation of data obtained from activity B-5 and other studies related to describing and evaluating physical conditions without and with the project. Information required in this analysis includes physical, chemical, and biological water data, determination of flow regime without and with the project, changes in sediment load and transport downstream, and entrapment rates, distribution and stratification within reservoirs, erosion potential in reservoir active storage zone and associated implications for water quality, ice conditions on reservoirs and downstream, and reservoir and downstream hydraulic effects of impoundment and altered flow regime. Downstream habitat changes will be determined, as will habitat lost (through inundation) or potentially created (access to streams formerly hydraulically blocked within reservoir areas) upstream from the dams. The potential for establishment of viable fisheries within the impoundments will also be assessed as part of this activity. Changes related to such things as velocity, predation, food production, cover, silt load, temperature, stream inundation, stream flow, and water quality will be evaluated in determining the likely effects of the project upon resident fish species.

Seasonal Constraint: None

Cost: $83,000

BIOLOGICAL STUDIES

Activity Designation: B-7

Activity: Identify and assess effects of altered outflow of the Susitna River upon the estuarine area in Upper Cook Inlet.

Description: Comments from numerous sources, including state officials responsible for sport and commercial fishing, indicate a concern for changes which might occur in existing habitat quality within Upper Cook Inlet, particularly the estuarine area at the mouth of the Susitna River. Baseline studies will be conducted to determine existing water quality and biological productivity within the estuarine area and the lower reach of the Susitna River. Points of consideration for studies not covered in those already cited include an evaluation of such things as sediment load, nutrient load, primary productivity, fresh/salt water stratification (wedges), tidal influence, and current regimes.

After sufficient hydrologic and hydrographic data has been collected and evaluated it will be reviewed to determine if the estuarine area will be significantly impacted by the project. They will determine the need for and the extent of further studies.

Seasonal Constraint: None

Cost: $232,000

BIOLOGICAL STUDIES

Activity Designation: B-8/8a

Activity: Identify and map moose habitat within impact areas, locate critical habitat, determine current habitat condition and trends, determine carrying capacity, and itentify water conditions associated with moose habitat.

Description: Available information indicates a heavy dependence upon the river bottoms and adjacent lands for winter range both above and below the proposed damsites. The purpose of this study is to identify and map vegetative types which provide moose habitat within the impoundment areas and downstream flood plain, and adjacent lands lost directly to flooding or potentially affected directly or indirectly by changes in flow regime. Downstream work will be accomplished in areas of project impact. In conjunction with activity B-9, areas of critical winter habitat will be defined, located, and mapped. Verification of use of plant species identified as preferred winter browse, the intensity of such use, and the general condtion of key browse species will be accomplished by field surveys consisting of locating and tagging and annually measuring browse growth and utilization. Browse growth rates will be established following the season of active annual growth in the fall, and utilization will be determined prior to new plant growth the following spring. Intensity of previous utilization will be determined and the general conditions and vigor of key species established. Results of this activity, along with data collected under activity B-9, will be utilized to estimate carrying capacity of winter ranges potentially affected by the project.

Location and abundance of moose browse is largely determined by soil moisture, which in turn is determined by conditions affecting the groundwater table. Plant species and areas representative of subclimax conditions are generally most productive of quality moose browse. It is suspected that the current pattern of natural annual flooding on the Susitna River produces conditions conducive to good moose browse production. The purpose of this study is to identify permanent and cyclic (annual) water conditions which affect browse production. This will require an analysis of historic seasonal streamflow data to identify the magnitude and frequency of flows which impart the most profound effect on vegetation. The area of concentration for this protion of the study consists of lands subjected to annual inundation along the mainstem Susitna River between Portage Creek and the mouth of the Chulitna River. Flooding

patterns without and with the project will be mapped on overlays on moose browse. On the basis of these comparisons, impacts on existing browse patterns and production will be estimated.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $400,000

BIOLOGICAL STUDIES

Activity Designation: B-9/9a

Activity: Identify moose subpopulations and determine the seasonal distribution, movement patterns, size and trend of those subpopulations within areas of project impact, and determine the timing and degree of subpopulation dependency on impacted habitat.

Description: The purpose of this study is to identify moose populations utilizing habitat subject to direct and indirect impact of the project, determine seasonal ranges and migration patterns of moose populations, determine what segments of each identified population utilize areas subject to direct or indirect project impact, and determine to what degree these animals are dependent on that habitat. Any apparent trend in moose populations will be identified and evaluted. Work will be accomplished by marking a number of moose in representative locations with radio transmitters, and by periodically locating and mapping their positions by aerial survey. This program will permit mapping of moose concentrations and movement, and will provide information required to determine sex and age composition of animals using various areas. Also, it will be possible to determine seasonal use of habitat types. Distribution and movement will be delineated by plotting locations on an overlay of the vegetative-type map prepared under activity B-1. This activity will furnish information which, in conjunction with data obtained from activity B-8, can be utilized to identify critical habitat as well as numbers of moose utilizing the study area. This procedure will be used to determine the yearly distribution of moose utilizing the impact area. The use of radios to transmit movement and population data will be supplemented by aerial reconnaissance to visually count moose, map concentrations, and determine sex and age composition of animals observed. Some of this information will be obtained during aerial surveys being conducted primarily for other purposes.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $624,000

BIOLOGICAL STUDIES

Activity Designation: B-10

Activity: Determine and evaluate project impacts on habitat and subpopulations of moose.

Description: Utilizing data obtained from activities B-1, 8, and 9, this study will determine both short- and long-term effects which the project is likely to have upon moose in the Susitna River drainage. The implications of total loss of all habitat subject to inundation will be assessed and evaluated as will the more subtle change expected to occur downstream as a result of changes in annual flooding patterns and a permanently altered river flow regime. Changes in present annual river flow and flood plain groundwater profiles will be evaluated as to the anticipated effects on riparian vegetation. Primary emphasis below the dams will be upstream from the confluence with the Chulitna River, with some analysis of possible changes between Chulitna River and Upper Cook Inlet. Impacts upon moose will be evaluated in terms of numbers likely to be lost, reduced, or forced to accept other available habitat.

Seasonal Constraint: None

Cost: $42,000

BIOLOGICAL STUDIES

Activity Designation: B-11/11a

Activity: Identify and map caribou habitat associated with alternate transmission corridors and areas subject to impoundment and determine the seasonal ranges and migration routes of caribou with emphasis on traditional migration routes with respect to the proposed impoundment areas.

Description: The purpose of this study is to identify caribou habitat within areas subject to project impact. Work will consist of identifying and mapping vegetative types known to provide caribou habitat. Vegetative-type maps provided by activity B-1 will be utilized as a base for producing overlays identifying and outlining vegetation known to be utilized by caribou. These maps will in turn be used as a base for overlays reflecting seasonal distribution of caribou.

The distribution studies will identify and quantify, to the extent practicable, caribou populations potentially affected by the project. Drastic declines have been reported in recent years in the Nelchina caribou herd. Current population condition and trend must be established in order to be able to recognize and identify impacts which may be attributable to the project. Baseline data collection will be accomplished by methodical aerial surveys. Populations will be quantified and mapped as to seasonal location and distribution. Aerial transects will be established and consistently flown in the same patterns to provide gross distribution and use data. Where animals are observed, intensive coverage of surrounding areas will be made in an attempt to obtain accurate counts. Particular emphasis during aerial surveys will be placed on determining the location and timing of migratory movement within the vicinity of the reservoirs. Caribou movement is known to vary from year to year; however, large numbers are known to usually cross the Susitna River in the vicinity of the reservoirs, particularly as they move from calving grounds to summer range. This activity will be supplemented by aerial surveys made in conjunction with moose radio tracking flights. Frequency of surveys will be increased during periods of spring migration.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $126,000

BIOLOGICAL STUDIES

Activity Designation: B-12

Activity: Determine and evaluate project impacts upon Nelchina caribou herd.

Description: The purpose of this activity is to determine, on the basis of data collected pursuant to activity B-11, the impacts which the project is likely to have on the Nelchina caribou herd. Two types of impacts are anticipated: one related to the influence of transmission lines on caribou movement and habitat utilization, and the other related to the construction of reservoirs bisecting migration routes between calving and summering grounds. Although little caribou habitat is likely to be destroyed by transmission line construction, more subtle impacts (related to increased accessibility of people and the consequent increased possibility of wild fire, and the visual contrast and sound associated with transmission lines) may have varying degrees of effects upon caribou, depending on the corridors chosen for construction of transmission facilities. Some caribou habitat may be inundated by reservoirs, but use of areas lying within the canyon of the Susitna River is probably minimal and transitory. Nevertheless, the time and duration of caribou use and the numbers utilizing the impoundment areas must be established before any conclusions can be made. Caribou are good swimmers, as evidenced by the numbers of newborn calves which apparently successfully cross the present river. However, it is not known whether deep water impoundment would provide more or less of a barrier. A major concern is that the creation of ice shelves formed as the impoundment is drawn down could significantly restrict movement and perhaps cause considerable mortality.

Seasonal Constraint: None

Cost: $15,000

BIOLOGICAL STUDIES

Activity Designation: B-13/13a

Activity: Inventory the number, size, territory, and other essential activity areas and determine and evaluate probable project impacts on wolf packs which inhabit areas that will be directly impacted by the project.

Description: The number of wolf packs and numbers of wolves in each pack will be inventoried, and territories and other essential areas will be located using radio-collar techniques and aerial surveys. Wolf relationships to various prey species in the project impact areas will be determined. This activity will be closely integrated with moose and caribou studies. A large part of the data required for this study will be obtained incidentally to aerial and ground surveys conducted in conjunction with other activities, particularly B-9 and B-11. Probable project impacts will be determined and evaluated.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $76,000

BIOLOGICAL STUDIES

Activity Designation: B-14/14a

Activity: Estimate black and brown/grizzly bear populations and distribution in the project impact area and determine and evaluate probable project impacts.

Description: Estimates of black and brown/grizzly bear populations and distributions in the project impact area, specifically the areas to be inundated, will be made. Most of these data will be obtained incidentally to aerial and ground surveys conducted in conjunction with other activities and by using radio collar techniques. Probable project impacts will be determined and evaluated.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None; however, field work will be concentrated during spring and fall.

Cost: $49,000

BIOLOGICAL STUDIES

Activity Designation: B-15/15a

Activity: Determine the general abundance and distribution of wolverines in the project impact area and determine and evaluate proabable project impacts.

Description: Estimates of the general abundance and distribution of wolverines in the project impact area will be made using aerial and ground surveys, and radio collar techniques. Most of these surveys will be made incidentally to other activities. Probable project impacts will be determined and evaluated.

The investigations and results will be reviewed annually to reevaluate the potential project impacts and redefine the study direction, as necessary.

Seasonal Constraint: None

Cost: $32,000

BIOLOGICAL STUDIES

Activity Designation: B-16/16a

Activity: Determine the relative abundance of Dall sheep inhabiting mountains adjacent to the project impact area and delineate seasonal ranges. Determine and evaluate probable project impacts.

Description: There is the possibility of adverse impacts on Dall sheep populations from human disturbance as a result of construction activities and increased access. Aerial surveys will be conducted to determine the size of the sheep population and to delineate seasonal ranges. Probable project impacts will be determined and evaluated.

Seasonal Constraint: None

Cost: $6,000

BIOLOGICAL STUDIES

Activity Designation: B-17/17a

Activity: Determine the relative abundance and distribution of fur bearer, small game, nongame, and bird species in the proposed impoundment areas and determine and evaluate probable project impacts.

Description: Little is known about the abundance and distribution of fur bearers, small game, nongame, and bird species in the project impact area. Limited aerial and ground surveys will be made in conjunction with other activities. Limited trapping will also be conducted. Distribution will be correlated with the vegetation-type maps produced under activity B-1. Probable project impacts will be determined and evaluated.

Seasonal Constraint: None

Cost: $20,000

BIOLOGICAL STUDIES

Activity Designation: B-18

Activity: Determine whether any rare and endangered species of plants, fish, birds, mammals, or other wildlife are present in the project area, and evaluate impacts of the proposed action on these species.

Description: Any rare or endangered species in the area of project impact will be identified in the course of other biological field investigations. Species lists should essentially be completed by the end of the second year of field studies which will be undertaken to identify vegetation, fish, birds, mammals, and other organisms. Upon identification of a rare or endangered species, intensive investigations of that particular organism will be undertaken immediately to determine its use, distribution, and number within impacted areas. The extent to which any of these factors will be influenced by the project will be determined and evaluated. Where applicable and possible, mitigative measures will be identified and evaluated. At the present time the peregrine falcon is the only endangered species known to occur in the area.

Seasonal Constraint: None; however, bulk of work will occur during snow-free periods.

Cost: $29,000

BIOLOGICAL STUDIES

Activity Designation: B-19

Activity: Determine annual harvest rates of species of fish and wildlife utilized for commercial and recreational purposes, and estimate changes expected as a result of the project. Determine importance of impacted species to regional populations.

Description: This study is essential to the accomplishment of activity B-20. Harvest of game animals, fur bearers, and sport and/or commercial species of fish will be determined by a combination of sampling devices including field checks (i.e., creel census), road blocks, established check stations, questionnaires, commercial fish ticket data, and returns from tagged anmimals. (Tagging, if accomplished, will be done primarily in relation to other biological studies.) This information will be evaluated in terms of physical effects of the project upon habitat and the extent to which improved accessibility by hunters and trappers may impact various species. The importance of impacted populations to regional populations will be determined by correlating estimated changes in harvest rate to average annual harvest.

Seasonal Constraint: None

Cost: $172,000

BIOLOGICAL STUDIES

Activity Designation: B-20

Activity: Identify and display damages to fish and wildlife in monetary terms and determine measures required to reduce or offset damages or to enhance existing habitat.

Description: This study is a requirement of the Fish and Wildlife Coordination Act of 1958, as amended. Procedures are outlined in Engineer Regulation 1105-2-129. Damages to fish and wildlife resources will be identified, and the economic value of such damages will be evaluated in monetary terms. Losses to the fish and wildlife resources causing a reduction in recreational fishing and hunting opportunities will be evaluated by procedures comparable to those used in evaluating benefits from these activities. Losses in commercial products (such as fish and pelts) will be expressed in monetary terms using the market values to the primary producers of the product net of associated production costs. Nonmonetary damages, including those impacts affecting the ecosystem and environmental quality, will be described in sufficient detail to support a judgement as to the cost that would be justified to prevent or offset them. Measures which are required for mitigating or compensating for damages shall be described. The costs will be determined, as will residual damages to fish and wildlife resources. If enhancement features are found to be justified, they will also be expressed in monetary terms. Benefits attributable to hunting and fishing, including sport fishing for anadromous fish as a direct result of the enhancement of fish and wildlife resources, will be evaluated in the same way as other forms of recreation. Data will be furnished through ongoing or previously conducted studies.

Seasonal Constraint: None

Cost: $100,000

BIOLOGICAL STUDIES

Activity Designation: B-21

Activity: Identify and describe environmental components and impacts related to each alternative identified as a possible solution to electrical energy needs.

Description: This activity requires a description of the environmental setting and the nature and use presently made of the environment associated with each alternative evaluated in the preliminary screening. This will be followed by a description of the environmental components affected by each alternative. The basis for estimating impacts of alternatives will be the comparison of existing physical, biological, and socio-economic characteristics of water and land supply, use and control, with and without a given action. Where quantitative data is lacking or not applicable, changes from the base condition will be sufficiently described to permit comparing various alternatives in regard to the relative magnitude of impacts associated with each alternative. Data required for this level of evaluation will be based essentially on existing sources.

Seasonal Constraint: None

Cost: $50,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION (RRP)

THIS FINAL CATEGORY OF ACTIVITIES IS A CONSOLIDATION OF ALL THE WORK ITEMS ASSOCIATED WITH THE ACTUAL WRITING OF REPORTS AND THEIR REVIEW. THE RESOURCES REQUIRED FOR CONDUCTING SEVERAL PUBLIC MEETINGS ARE ALSO INCLUDED.

INITIAL PUBLIC INVOLVEMENT.

1. Conduct initial public meeting with supporting public involvement activities.

PRELIMINARY SCREENING.

2. Prepare preliminary hydrology studies report.
3. Prepare preliminary site selection report.
4. Prepare preliminary environmental studies report.
5. Prepare preliminary marketability analysis.
6. Prepare and submit draft plan formulation report.
7. Conduct second public meeting.

REPORT PREPARATION.

8. Prepare Hydrology appendix.
9. Prepare Power Studies appendix.
10. Prepare Site Selection appendix.
11. Prepare Plan Formulation appendix.
12. Prepare Transmission Facilities appendix.
13. Prepare Access appendix.
14. Prepare Foundation and Materials appendix.
15. Prepare Real Estate appendix.
16. Prepare Design and Cost Estimate appendix.
17. Prepare Marketing Analysis appendix.
18. Prepare Environmental Studies appendix.
19. Prepare Recreation appendix.
20. Prepare Cultural Resources appendix.
21. Prepare and submit draft Project Analysis.
22. Prepare and submit supplemental EIS.
23. Prepare and submit Project Feasibility Analysis, Main Report.

FINAL REPORTS AND REVIEWS.

24. Conduct Final Review.
25. Prepare and submit revised Project Feasibility Analysis Report.
26. Prepare and submit revised Supplemental EIS.

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-1

Activity: Conduct initial public meetings.

Description: The initial public meetings will be held as early as possible after initiation of the project feasibility analysis. The purpose of this early public involvement is to inform the public of the post-authorization planning being undertaken and to elicit public response to the planned studies. Information contained in the Plan of Study will be widely distributed in advance of the meetings and will serve as the primary topic for discussion.

Cost: $15,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-2

Activity: Prepare preliminary hydrology studies report.

Description: This document will provide the information to be used in the power studies and plan formulation for preliminary screening. Primary information will include monthly streamflows for each of the damsites to be evaluated. It will also include information on evapotranspiration rates for the critical streamflow period, elevation capacity curves for the reservoirs, and preliminary information on the spillway design flood.

Seasonal Constraint: None

Cost: $3,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-3

Activity: Prepare preliminary site selection report.

Description: This report will present the analysis and considerations that went into developing hydro plans for the initial screening of alternatives. It will include a discussion of preliminary site layouts and cost estimate.

Seasonal Constraint: None

Cost: $3,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-4

Activity: Prepare preliminary environmental studies report.

Description: This activity will consist of preparing a summary description and comparison of the biological and socio-economic impacts of the various alternative solutions selected for analysis. Data upon which this activity is based will be assembled under activity B-21 and EC-3. The contents of this report will be utilized in the preliminary screening.

Seasonal Constraint: None

Cost: $3,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-5

Activity: Prepare preliminary marketability analysis.

Description: This report will present the review of load growth and marketing assumptions to be used in evaluating the economic feasibility of the various plans for hydro development. It will include, as a minimum, seasonal load duration curves, power demand projections, and other marketing assumptions on the saleability of Susitna power during the early years of operation and over its economic life. This information will be used to support the preliminary screening.

Seasonal Constraint: None

Cost: $3,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-6

Activity: Prepare and submit draft plan formulation report.

Description: The results of the preliminary screening of energy alternatives will be presented in a plan selection report. Those alternatives, at least one of which will be a nonhydro plan, that merit further study will be identified and carried forward for additional refinement and evaluation during the detailed feasibility analysis. The report will contain a description of each alternative plan, the power capability and associated benefits of each plan, differential environmental impacts and plan costs.

Seasonal Constraint: None

Cost: $6,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-7

Activity: Conduct second level public meetings.

Description: This second set of public meetings is designed to foster public participation in the screening of alternative energy plans. Additionally, input will be sought from residents of the immediate project area to establish a most probable future that will serve as a frame of reference in the impact assessment process. In advance of the meetings, informational material summarizing the preliminary screening process will be widely disseminated.

Seasonal Constraint: None

Cost: $15,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-8

Activity: Prepare Hydrology appendix.

Description: This activity entails the compilation and presentation of the basic hydrologic information upon which the project will be based. Streamflow data will include extended monthly volumes for the three existing stations and the six new gages to be installed. The streamflow throughout the basin will then be characterized by a number of statistical techniques to include seasonal flow duration curves, peak and volume frequency curves, and low flow frequency curves. The collection of data will allow a definitive description of the hydrology and climate within the basin and along the transmission line corridor. Also presented will be sediment transport studies that will attempt to define total sediment transport rates, reservoir entrapment rates, and downstream channel changes as a result of reservoir deposition. The appendix will address the potential for discharge control and the possibility of handling reservoir sediment stratification. The results of water quality studies, erosion potential investigations, ice studies, and spillway design flood analyses will also be included.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-9

Activity: Prepare Power Studies appendix.

Description: This appendix will include all power studies to be conducted for plan formulation and more specifically for indepth analysis of the selected plan of development. Power studies for plan formulation will entail seasonal regulation analysis and hourly studies to determine the need for a reregulation reservoir. These studies will establish the energy capabilities of the various plans of development for a number of assumed dam heights and active storage volumes. There will be no attempt to incorporate economic evaluation into these studies as this will be accomplished under plan formulation. For the selected plan, a number of load shape studies will be conducted to determine the optimum mode in which the projects should be operated. The report will include head duration curves, tailwater duration curves, turbine efficiency curves, and suggested operating role curves.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-10

Activity: Prepare Site Selection appendix.

Description: The purpose of this activity is to present the damsites identified and the considerations which resulted in specific recommendations as to dam types and heights for each site. Findings of the preliminary geologic studies which assessed suitability of foundations, quantity and quality of construction materials and good and bad physical features will be presented. In particular, features which will limit the height or type of dam considered at a site will be noted. Mass quantities and cost height relationships will be prepared, preliminary analyses performed and the favorable and unfavorable points of each site evaluated. This activity will also present the mechanics of the reviewing process and the rationale by which the specifics sites were selected.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-11

Activity: Prepare Plan Formulation appendix.

Description: The purpose of this appendix will be to present the procedures and rationale by which the recommended plan of development is selected. The basic procedure will entail objective identification, assessment of available alternatives, and comparison of alternatives from the primary standpoints of economic enhancement and environmental preservation. Plan selection will be based on that plan which provides the greatest contributions to the study objectives. Formulation will require a synopsis of the findings of the power economics analysis, hydropower operation studies, and an impact assessment associated with the various alternative energy resources as well as specific development plans within the Upper Susitna Basin. Because of their obvious inability to meet the study objectives many of the energy alternatives can be eliminated early in the study process. After preliminary screening, the selected plan or plans will be refined as to dam height, operating characteristics, etc., and this refinement process will also be included in this appendix. The economic and effect assessment will be presented not only for the most feasible plan for hydro development, but also for the most likely energy alternative that would be developed if the hydro system were not.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-12

Activity: Prepare Transmission Facilities appendix.

Description: This appendix will present the studies involved in selecting of transmission line routes, towers, conductor and hardware, substations and switchyards, and other items of the transmission facilities. The alternate routes studied, the foundation studies, studies on towers, hardware and conductors, and clearing considerations will be included in the appendix with a final recommendation of the selected route, tower types and all hardware.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-13

Activity: Prepare Access appendix.

Description: Under this activity the access route alternatives will be outlined, and the considerations which resulted in the selection of a specific route will be presented. Vertical and horizontal alignments will be shown and their advantages and disadvantages relative to grade, curvature, distance, bridge requirements and foundations will be presented. Particular emphasis will be placed on the requirement for an all weather access and the potential winter problems of snow and ice. Bridge needs will be assessed and preliminary designs included. Foundation conditions as revealed by preliminary explorations will also be included in this appendix.

Cost: $10,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-14

Activity: Prepare Foundations and Materials appendix.

Description: The results of the exploration, testing and evaluation for geological and foundation conditions will be presented in a Foundations and Materials appendix. Special emphasis will be placed on presenting the results of seismic testing and determination of the design earthquake.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-15

Activity: Prepare Real Estate appendix.

Description: Data previously collected will be synthesized into a workable format. A draft will be prepared of all pertinent real estate data to include an overall real estate project map with more detailed segment maps. A gross appraisal will be prepared with supporting narrative to provide technical justification for land costs.

Seasonal Constraint: None

Cost: $40,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-16

Activity: Prepare Design and Cost Estimates appendix.

Description: The purpose of this appendix will be to describe the various features of the selected plan and to identify feature costs. Included will be discussions of dam type and height, foundation conditions, material sources, and general configuration of spillway and outlet works, penstocks and powerhouse, intake systems and gates, and other dam features. Other project components such as construction facilities and reservoir clearing will also be described.

Seasonal Constraint: None

Cost: $20,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-17

Activity: Prepare Marketing Analysis appendix.

Description: This report will summarize the various power market studies and will present the load growth and power system assumptions that underlie the detailed feasibility analysis. In addition, it will contain a detailed assessment of existing power plant retirement and financial feasibility based on the selected plan.

Seasonal Constraint: None

Cost: $7,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-18

Activity: Prepare Environmental Studies appendix.

Description: This work will consist of a consolidation and summarization of the results of the biological and socio-economic studies. As such, it will serve as a reference document for the impact assessment process and for preparation of the Environmental Impact Statement Supplement.

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-19

Activity: Prepare Recreation appendix.

Description: The Recreation appendix will be prepared upon completion of all recreation-related activities. Plates detailing proposed recreational developments will be prepared following selections of the best alternative scheme. The process of recreation plan selection will also be explained.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-20

Activity: Prepare Cultural Resources appendix.

Description: This Cultural Resources Reconnaissance Report will present the findings of both the archeological and historical studies. Included will be information relating to the number and types of archeological and historical resources in the project area and the probable impact of the project on those resources.

Seasonal Constraint: None

Cost: $14,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-21

Activity: Prepare and submit draft project analysis.

Description: The results of the detailed feasibility studies of the best plan identified will be presented in a project analysis report. The analysis will be made using the detailed information and data obtained from marketing, environmental, hydrological, and foundation studies. The marketing studies will entail refined cost estimates based on expanded information available from the foundation exploration program and project benefits will be determined from power studies and production cost analysis. The environmental studies will provide sufficient information to allow identification of probable magnitude of impacts and evaluation of project feasibility. Power studies will be derived from output provided by hydrological evaluation. The report will provide a firm basis for recommending for or against construction of the project.

Seasonal Constraint: None

Cost: $50,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-22

Activity: Prepare and submit supplemental EIS.

Description: This work will consist of further summarization of all environmenal, economic, social, and engineering studies accomplished during the project feasibility analysis. Impacts from the various features of the project will be evaluated and presented narratively. Detailed information will be presented on the recommended plan, while impacts of alternative actions will be described sufficiently to fully inform readers and decision makers of the trade-offs and reasons involved in their rejection.

Seasonal Constraint: None

Cost: $26,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-23

Activity: Prepare and submit Project Feasibility Analysis, Main Report.

Description: Following completion of the detailed feasibility studies, the detailed dam design, and the various appendices, the Main Report will be prepared. It will be a summary document that explains the sequential planning steps that resulted in the recommended plan, the various elements of that plan, and the associated costs and benefits. It will also present recommendations for plan implementation.

Seasonal Constraint: None

Cost: $21,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-24

Activity: Conduct final review.

Description: This activity establishes time and resources for a thorough review of the project feasibility analysis. Included as part of this review will be coordination of draft documents with concerned Federal and State agencies, as well as a third set of public meetings.

Seasonal Constraint: None

Cost: $45,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-25

Activity: Prepare and submit revised Project Feasibility Analysis Report.

Description: After all work indicated by the final review is completed and after the report has been revised to reflect input from public involvement and interagency coordination, the final report will be prepared and submitted.

Seasonal Constraint: None

Cost: $40,000

REPORTS, REVIEWS, AND PUBLIC PARTICIPATION

Activity Designation: RRP-26

Activity: Prepare and submit revised Supplemental EIS.

Description: Work will be initiated immediately upon receipt of comments following the 45-day review period to prepare written responses to individual comments. This will require an intensive effort over a short time span by a task group familiar with DEIS and by other specialists who developed data for the project feasibility analysis.

Seasonal Constraint: None

Cost: $67,000

AVAILABLE DATA

A number of documents are available which discuss the general setting of the Upper Susitna River Basin and the surrounding communities that would be served by the proposed hydro project. Also available are several reports which address specific development of the Susitna Basin. The following list of reports includes only some of the more pertinent studies relative to the Railbelt environment. More detailed is the listing of the reports which describe studies of the Upper Susitna River Basin. Many of the reports consist of one-of-a-kind documents which are available only through the Corps of Engineers or other agencies, while others can be obtained through libraries, governmental agencies, or private organizations.

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GLOSSARY

adit - a horizontal gallery driven from the surface giving access to a work area.

alluvium - material eroded, transported, and deposited by streams.

anemometer - a device which measures air speed.

arcuate - bow shaped or bent.

aquifer - a subsurface zone that yields economically important amounts of water to wells.

backwater curve - a curve showing high-water surface on a given stream resulting from downstream obstructions, or high stages in an intersecting stream.

batholith - a huge mass of igneous rock of irregular shape and great extent in all dimensions.

bell mouth - flared mouth on a pipe opening.

block faulting - see fault block.

B.O.D. - biochemical oxygen demand.

bus - a set of two or more electric conductors that serve as common connections between load circuits and each of the polarities (direct current) or phases (alternating current) of the source of electric power.

C.O.D. - chemical oxygen demand (of water).

critical path method (CPM) - a method of scheduling activities by which the activities are placed in sequential order and given time estimates so that the most time-consuming activity is identified. The most time-consuming activity, or series of interdependent activities, constitute the critical path.

dendritic - having a branching, treelike pattern or structure.

dependable capacity - the assured peak load; carrying ability of a plant or system under adverse water conditions for the time interval and period specified when related to the characteristics of the load to be supplied, expressed in kilowatts (or megawatts).

diastrophism - process or processes by which the earth's crust is deformed; the results of this action.

drawdown - the distance that the water surface of a reservoir is lowered from a given elevation as the result of the withdrawal of water.

elevation versus capacity curves - graphic representation of the relationship between the elevation and the storage capacity of a reservoir.

fault - a fracture in rock along which the adjacent rock surfaces are differentially displaced.

fault block - a rock mass which is bounded by faults.

firm energy - energy required to be available at all times.

frazil ice - a spongy accumulation of ice crystals which form in supercooled turbulent water.

glacial moraine - an accumulation of glacial debris (drift) deposited by glacial action.

grout curtain - a row of drilled holes filled with grout under pressure to form a seepage barrier under a dam.

head - (of pressure) - height of a column of fluid necessary to develop a specific pressure.

hydrograph - a graphical representation of stage, flow, velocity, or other characteristics of water at a given point as a function of time.

hydrometeorological - that part of meteorology directly related to hydrologic problems such as flood control, irrigation, or hydroelectric power.

initial sunk costs - project costs previously expended.

in situ - in the original location.

invert - the floor or bottom of a conduit.

lateral slipping - horizontal movement of rock along a fracture.

limnological - related to the science of life and conditions for life in lakes, ponds and streams.

manuscript mapping - original drawing produced from mapping instrument.

orographic effects - effects on air currents caused by mountains.

passerines - perching birds.

penstock - a closed water conduit controlled by valves and located between the intake and the turbine in a hydroelectric plant.

photomosaic - composite photograph made up of individual, small-area photos placed side by side.

photo/topo - the mapping of surface features by means of aerial photography.

picture point aerial photography - photographs taken after target panels are placed on the ground or after existing objects are identified which can later be located in the photography.

plate jacking test - a test for quality of foundation rock, in which plates are cemented to rock walls (usually of a tunnel), then pressure is applied by a huge hydraulic jack. Deflection of the rock under pressure, and rebound of the rock after the pressure is removed, gives indication of the quality of the foundation.

rime icing - a milky, opaque, granular deposit formed by the rapid freezing of super-cooled water drops on an exposed surface; composed essentially of separate ice granules.

riparian - living or located on a riverbank.

river cross section - a depiction of the contours of the river bottom.

secondary energy - electric energy having limited availability. In a good water year, a hydro plant can generate energy in excess of its prime energy capability. This excess energy is classified as secondary energy because it is not available every year, and varies in magnitude in those years when it is available.

shotcrete - pneumatically placed concrete.

steel bent - a framework support transverse to the length of a structure.

tailwater rating curve - depiction of discharges (flow rates at given instants expressed as volume per unit of time) in relation to the elevation of the water surface. These curves indicate discharge for various stage elevations.

tectonics - a branch of geology dealing with rock structure and external forms of the earth's crust.

telemetry - transmitting of instrument readings to a remote location by means of wires, radio, etc. Remote metering.

tiltmeter - an instrument used to measure small changes in the tilt of the earth's surface, usually in relation to a liquid-level surface or to the rest position of a pendulum.

user day values - Cost/benefit values derived from calculations in which a user day is defined as any part of a day spent in a particular recreational activity.

volcanism - the movement of molten rock from the interior of the earth into the crust and to the surface.

water surface profile - a graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above the stream mouth. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Table 1. Tabulation of Program Activities According to Cost and Year of Accomplishment.

	Cost ($1,000)	Year 1	2	3	4
SURVEY (SY)					
RIVER CROSS SECTION					
1. Obtain river cross sections at preliminary sites.	50	*			
2. Obtain river cross sections downstream.	300	*			
MAPPING					
3. Map potential reservoir sites.	460	*			
4. Obtain controlled photo/topo along access route.	225	*	*		
5. Obtain controlled photo/topo along transmission corridor.	70	*			
6. Obtain controlled photo/topo at Watana damsite.	15	*			
7. Obtain controlled photo/topo at Devil Canyon.	60	*			
HYDROLOGY (HY)					
IMPLEMENT A DATA COLLECTION PROGRAM.					
1. Collect climatologic data for basin and transmission line.	423	*	*		
2. Install and operate additional stream gages and continue stream gaging.	300	*	*		
3. Collect water data.	60	*	*	*	
DESCRIBE HYDROMETEOROLOGICAL SETTING OF BASIN.					
4. Describe hydrometeorological setting.	8		*		
CONDUCT PRE-PROJECT STREAMFLOW ANALYSIS.					
5. Extend streamflow and correlate with longest record.	10	*			
6. Develop annual and seasonal flow duration curves.	2		*		
7. Develop peak and volume frequency curves.	2		*		
8. Develop low flow frequency analysis for critical period.	10		*		
CONDUCT RESERVOIR AND DOWNSTREAM SEDIMENT STUDIES.					
9. Determine average annual total load.	35	*	*		
10. Determine entrapment rates and reservoir distribution.	20		*	*	
11. Determine reservoir suspended sediment stratification.	15	*			
12. Determine effect on downstream channel.	20		*		

	Cost ($1,000)	Year 1	2	3	4
HYDROLOGY (HY (Cont.)					
SPILLWAY DESIGN FLOOD DERIVATION.					
13. Obtain final Probable Maximum Precipitation from HMB-NWS.	1		*		
14. Recalibrate basin Model.	25		*		
15. Determine Probable Maximum Flood and route through reservoir.	15		*		
WATER SURFACE PROFILE DETERMINATION.					
16. Determine wter surface profiles from Talkeetna to Watana.	25	*	*		
CONDUCT ICE STUDIES.					
17. River and reservoir conditions.	130	*	*		
18. Review literature about existing storage projects in arctic conditions.	20		*		
WIND AND ICE STUDIES REQUIRED FOR TRANSMISSION LINE DESIGN.					
19. Conduct literature search and limited field survey.	15		*		
POST PROJECT STREAMFLOW ANALYSIS.					
20. Develop post-project frequency curves.	1		*		
21. Determine post-project downstream water surface profiles.	20		*		
RESERVOIR FILLING SCHEDULES.					
22. Develop reservoir filling schedules.	9	*	*	*	
GLACIAL BALANCE STUDIES.					
23. Conduct mass water yield studies.	55	*	*	*	
24. Conduct mass sediment yield studies.	55	*	*	*	
EVAPOTRANSPIRATION STUDIES.					
25. Determine evaporation rates.	10	*			
OTHER ACTIVITIES.					
26. Provide preliminary spillway design flood.	1	*			
27. Determine elevation versus capacity relationships.	8	*			
ENVIRONMENTAL (EN)					
WATER QUALITY STUDIES.					
1. Collect chemical and biological water quality data.	140	*	*	*	

	Cost ($1,000)	Year 1	2	3	4
ENVIRONMENTAL (EN) (Cont.)					
2. Reservoir temperature stratification studies and reservoirs water quality modeling.	150		*	*	
3. Analyze spillway and outlet works for dissolved gas production.	20		*		
4. Assess erosion potential in active storage zone.	20		*		
ECONOMICS (EC)					
MISCELLANEOUS ECONOMIC STUDIES.					
1. Perform employment benefit analysis.	5			*	
2. Prepare flood damage prevention analysis.	12	*	*		
SOCIO-ECONOMIC IMPACT STUDIES.					
3. Conduct preliminary socio-economic impact studies for initial screening of alternatives.	11	*			
4. Develop detailed profiles of socio-economic conditions in the immediate project area, the region, and the State.	15	*	*		
5. Forecast future "without-project" conditions.	15			*	
6. Forecast future "with project" conditions.	20			*	
7. Identify and evaluate significant socio-economic effects.	6			*	*
RECREATION (R)					
RECREATION PLAN					
1. Conduct data search and evaluation.	5	*			
2. Conduct supply and demand analysis.	20	*			
3. Develop alternative plans for public recreation and related resources uses.	15		*		
4. Conduct cost/benefit evaluation of alternative plans and select final plan.	16		*	*	
PLAN FORMULATION (PF)					
REVIEW OF PREVIOUS STUDIES.					
1. Review 1976 feasibility report.	1	*			
2. Update power values.	3	*			

	Cost ($1,000)	Year 1	2	3	4
PLAN FORMULATION (PF) (Cont.)					
EVALUATION CRITERIA.					
3. Establish evaluation criteria.	5	*			
PLANS AND PRELIMINARY EVALUATION.					
4. Identify possible solutions.	8	*			
ANALYZE SPECIFIC PLANS OF HYDROPOWER DEVELOPMENT.					
5. Establish site layouts.	40	*			
6. Conduct mass take-offs and provide cost estimates.	-	*			
7. Assess reregulation dam costs.	1			*	
8. Develop power benefits and assess economic attractiveness.	10	*			
IMPACT IDENTIFICATION AND EVALUATION.					
9. Make preliminary assessment of alternatives.	5	*			
ON-GOING EVALUATION OF ALTERNATIVES.					
10. Update the impact analysis as needed.	20			*	*
IDENTIFICATION OF HYDRO SYSTEM OPERATION IN REGIONAL LOAD.					
11. Study feasibility of future units and downstream reregulation.	4			*	
12. Conduct hourly loading studies.	3			*	
13. Assess sensitivity to load growth.	1			*	
ALTERNATIVE SYSTEM STUDIES.					
14. Conduct system studies on alternative developments.	20			*	
BENEFIT AND COST CALCULATION.					
15. Collect and compare benefit and cost estimates.	3			*	
POWER STUDIES (PS)					
MISCELLANEOUS POWER STUDIES.					
1. Identify optimum dam heights, reservoir storage and optimum power.	40	*			
2. Conduct hourly simulated operation.	70		*		
3. Evaluate downstream impacts with and without a regulating dam.	40		*		
4. Develop production cost model.	48		*		

	Cost ($1,000)	Year 1	2	3	4
POWER MARKET STUDIES (PM)					
PRELIMINARY LOAD GROWTH ANALYSIS.					
1. Update power market analysis from feasibility report.	6	*			
DETAILED LOAD GROWTH AND POWER MARKET ANALYSIS.					
2. Prepare socio-economic base study.	75	*			
3. Forecast future development.	28	*			
4. Prepare employment and population forecasts.	11	*			
5. Describe existing and planned power generation through 1985.	3	*			
6. Assess electric energy use trends.	15	*			
7. Develop electricity demand forecasts by sector.	50	*			
8. Develop load distribution data and duration curves.	15	*			
9. Assess long term power outlook and system requirements.	25	*	*		
10. Evaluate the retirement of existing and planned power plants.	14	*			
11. Evaluate alternative power sources.	75		*		
12. Assess project financial feasibility.	30			*	*
FERC LICENSE					
13. Prepare material for draft FERC license.	150				*
FOUNDATIONS AND MATERIALS (FM)					
REGIONAL GEOLOGY.					
1. Conduct regional geology study, fault study, and seismicity evaluation.	470	*			
SEISMIC MONITORING.					
2. Install seismic monitoring system.	310	*			
3. Operate seismic monitoring system and analyze data.	225	*	*	*	*
ACCESS ROAD.					
4. Select route.	18	*			
5. Conduct site geology and soils study.	370		*	*	*
6. Explore and test for access road.	1,460		*	*	*
TRANSMISSION LINE.					
7. Select route.	35	*			
8. Conduct site geology and soils study.	185		*	*	
9. Explore and test.	830		*	*	
10. Conduct foundation and materials design.	80		*	*	

	Cost ($1,000)	Year 1	2	3	4
FOUNDATIONS AND MATERIALS (FM)					
WATANA SITE.					
11. Conduct site geology study.	-	*	*	*	
12. Explore and test for site selection.	210	*	*		
13. Explore for potential construction materials sources.	845	*	*	*	
14. Evaluate site selection and dam.	170	*	*		
15. Explore and test for final design.	1,820		*	*	*
16. Conduct geophysical investigations.	93		*	*	*
17. Perform concrete studies.	265		*	*	*
18. Perform feature design for embankment dam, cofferdams and diversions. (F&M aspects).	910		*	*	*
19. Perform feature design for spillway, powerhouse and outlet works (F&M aspects).	410		*	*	*
DEVIL CANYON SITE.					
20. Conduct site geology study.	35		*	*	
21. Explore and test for site selection.	650	*	*	*	
22. Evaluate for site selection and dam type.	-	*	*	*	
23. Study rock mechanics and conduct in-situ testing.	280	*	*	*	
24. Conduct concrete aggregate studies.	85	*	*	*	
OTHER SITES.					
25. Conduct field reconnaissance.	8	*			
26. Explore and test for site selection and dam type.	6	*			
DESIGN (D)					
PRELIMINARY SCREENING.					
1. Make preliminary selection of potential damsites.	12	*			
2. Conduct site inspection.	28	*			
3. Determine types and heights of dams.	34	*			
4. Determine powerhouse size and location.	25	*			
5. Develop diversion scheme.	25	*			
6. Develop water passages.	40	*			
7. Estimate project costs.	17	*			
DETAILED FEASIBILITY STUDIES (WATANA AND DEVIL CANYON).					
8. Study dam type and height.	90	*	*	*	
9. Study spillways.	68	*	*	*	
10. Study outlet works.	66	*	*	*	
11. Study water diversion and care.	62	*	*	*	
12. Study powerhouse size, type and location.	100	*	*	*	
13. Study power intake and conduit.	200	*	*		
14. Estimate selected project cost.	16	*	*		

	Cost ($1,000)	Year 1	2	3	4
DESIGN (D) (Cont.)					
DETAILED DAM ANALYSIS (WATANA SITE).					
15. Study dam type and height.	50		*	*	*
16. Study spillways.	406		*	*	*
17. Study outlet works.	498		*	*	*
18. Study water diversion and care.	393		*	*	*
19. Study powerhouse size, type and location.	200		*	*	*
20. Study power intake and conduit.	720		*	*	*
21. Estimate selected project cost.	18		*	*	
TRANSMISSION FACILITIES.					
22. Conduct route studies.	250	*	*	*	
23. Conduct transmission system study.	36	*	*	*	
24. Conduct tower, hardware, and conductor studies.	55	*	*	*	
25. Conduct foundation type studies.	30	*	*		
26. Conduct substation studies.	114	*	*		
27. Conduct switchyard studies.	76	*	*		
28. Estimate transmission facilities cost.	18	*	*		
ACCESS ROADS.					
29. Conduct route studies.	78	*	*	*	*
30. Conduct bridge studies.	60		*		
31. Estimate selected route costs.	21		*		
RESERVOIR CLEARING.					
32. Conduct field survey.	8	*			
33. Conduct marketability and disposal study.	20	*			
34. Estimate clearing costs.	8	*			
CONSTRUCTION AND PERMANENT CAMP FACILITIES.					
35. Determine requirements.	30	*	*		
36. Study locations and layouts.	40	*	*		
37. Estimate camp costs.	10	*	*		
OTHER HYDRAULIC CONSIDERATIONS.					
38. Study upstream and downstream effects.	75	*	*		
39. Determine model studies to consider.	4		*		
REAL ESTATE (RE)					
INVESTIGATIONS AND DETERMINATIONS.					
1. Conduct real estate field investigations.	7	*	*		
2. Make real estate legal determinations.	33		*		

	Cost ($1,000)	Year 1	2	3	4
REAL ESTATE (RE) (Cont.)					
RIGHTS OF ENTRY.					
3. Obtain rights of entry for survey and exploration at dam sites.	2	*			
4. Obtain rights of entry for survey and exploration along access road.	6	*			
5. Obtain rights of entry for survey and exploration along transmission corridor.	11	*			
CULTURAL RESOURCES					
ARCHEOLOGICAL					
1. Conduct an archeological reconnaissance.	100	*	*	*	
HISTORICAL					
2. Locate, map, and describe all significant historic properties within areas of project impact.	10	*	*	*	
FIELD CAMP (FC)					
FIELD CAMP					
1. Design, construct, and operate field camp.	1,500	*	*	*	*
AIR FIELD					
2. Design and construct airstrip.	125	*			
BIOLOGICAL STUDIES (B)					
VEGETATIVE COVER.					
1. Obtain necessary aircraft/satellite imagery and utilize manual interpretive techniques and automatic data processing techniques to type vegetation within areas of project impact.	158	*	*		
STUDIES OF AQUATIC ANIMAL AND PLANT LIFE.					
2. Identify and determine project impacts on significant invertebrate species.	127	*	*		
ANADROMOUS FISHERY STUDIES.					
3. Determine relative abundance, distribution, migrational characteristics, and habitat requirements of anadromous fish within impacted areas, and locate and define the seasonal freshwater habitat requirements important to the successful migration, spawning, incubation, and rearing of these species.	1,061		*	*	*
4. Determine project effects on anadromous fish.	83				*

	Cost ($1,000)	Year 1	2	3	4
BIOLOGICAL STUDIES (B) (Cont.)					
RESIDENT FISH STUDIES.					
5. Determine relative abundance, distribution, and habitat requirements of resident fish within impacted areas, and locate habitat critical to successful spawning and rearing of these species.	778	*	*	*	
6. Determine project effects on resident fish.	83			*	
ESTUARINE STUDIES.					
7. Identify and assess effects of altered outflow of the Susitna River upon the estuarine area in upper Cook Inlet estuary.	232		*	*	
MOOSE STUDIES.					
8. Identify and map moose habitat within impacted areas, locate critical habitat, determine habitat condition and carrying capacity, and identify water conditions associated with moose habitat.	400	*	*	*	
9. Identify moose subpopulations and determine the seasonal distribution, movement patterns, size and trend of those subpopulations within areas of project impact, and determine the timing and degree of subpopulation dependency on impacted habitat.	624	*	*	*	
10. Determine impact of project upon moose habitat and populations.	42			*	
CARIBOU STUDIES.					
11. Identify and map caribou habitat associated with alternate transmission corridors and areas subject to impoundment and determine the seasonal ranges and migration routes of caribou with emphasis on traditional migration routes with respect to the proposed impoundment areas.	126	*	*	*	
12. Determine project impacts upon Nelchina caribou herd.	15			*	
STUDIES OF OTHER MAMMALS.					
13. Inventory the number, size, territory, and other essential activity areas and determine and evaluate probable project impacts on wolf packs which inhabit areas that will be directly impacted by the project.	76	*	*	*	

	Cost ($1,000)	Year 1	2	3	4
BIOLOGICAL STUDIES (B) (Cont.)					
STUDIES OF OTHER MAMMALS.					
14. Estimate black and brown/grizzly bear populations and distribution in the project impact area and determine and evaluate probable project impacts.	49	*	*	*	
15. Determine the general abundance and distribution of wolverines in the project impact area and determine and evaluate probable project impacts.	32	*	*	*	
16. Determine the relative abundance of Dall sheep inhabiting mountains adjacent to the project impact area and delineate seasonal ranges. Determine and evaluate probable project impacts.	6	*	*	*	
17. Determine the relative abundance and distribution of fur bearer, small game, nongame, and bird species in the proposed impoundment areas and determine and evaluate probable project impacts.	20	*	*		
STUDIES OF RARE AND ENDANGERED SPECIES.					
18. Determine whether any rare and endangered species of plants, fish, birds, mammals, or other wildlife are present in the project area, and evaluate impacts of the proposed action on these species.	29		*	*	
STUDIES RELATED TO ECONOMIC VALUE OF FISH AND WILDLIFE.					
19. Determine annual harvest rates of species of fish and wildlife utilized for commercial and recreational purposes, and estimate changes expected as a result of the project. Determine importance of impacted species to regional populations.	172	*	*	*	
20. Identify and display damages to fish and wildlife in monetary terms and determine measures required to reduce or offset damages or to enhance existing habitat.	100				*
IMPACTS OF ENERGY ALTERNATIVES.					
21. Identify and describe environmental components and impacts related to each alternative identified as a possible solution to electrical energy needs.	50	*			

	Cost ($1,000)	Year 1	2	3	4
REPORTS, REVIEWS, AND PUBLIC PARTICIPATION (RRP)					
INITIAL PUBLIC INVOLVEMENT.					
1. Conduct initial public meeting with supporting public involvement activities.	15	*			
PRELIMINARY SCREENING.					
2. Prepare preliminary hydrology studies report.	3	*			
3. Prepare preliminary site selection report.	3	*			
4. Prepare preliminary environmental studies report.	3	*			
5. Prepare preliminary marketability analysis.	3	*			
6. Prepare and submit draft plan formulation report.	6	*			
7. Conduct second public meeting.	15	*	*		
REPORT PREPARATION.					
8. Prepare Hydrology appendix.	14				*
9. Prepare Power Studies appendix.	14			*	
10. Prepare Site Selection appendix.	14			*	*
11. Prepare Plan Formulation appendix.	14				*
12. Prepare Transmission Facilities appendix.	14				*
13. Prepare Access appendix.	10				*
14. Prepare Foundation and Materials appendix.	14				*
15. Prepare Real Estate appendix.	40			*	*
16. Prepare Design and Cost Estimate appendix.	20				*
17. Prepare Marketing Analysis appendix.	7			*	*
18. Prepare Environmental Studies appendix.	14				*
19. Prepare Recreation appendix.	14			*	
20. Prepare Cultural Resources appendix.	14			*	*
21. Prepare and submit draft project analysis.	50			*	
22. Prepare and submit supplemental EIS.	26				*
23. Prepare and submit Project Feasibility Analysis, Main Report.	21			*	
FINAL REPORTS AND REVIEWS.					
24. Conduct Final Review.	45				*
25. Prepare and submit revised Project Feasibility Analysis Report.	40				*
26. Prepare and submit revised Supplemental EIS.	67				*

MONTHS

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46

ADVANCED PREPARATION

PRELIMINARY SCREENING

DETAILED FEASIBILITY STUDIES

DETAILED DESIGN STUDIES

BIOLOGICAL STUDIES

HYDROLOGY STUDIES

SITE SELECTION

FEASIBILITY STUDIES DEVIL CANYON AND WATANA

WATANA

CLEARING

CAMP

ACCESS

TRANSMISSION

INITIAL MOBILIZATION

PRELIM. OFFICE STUDIES

INITIAL CONTRACT ACTIVITIES

RE 3,4 & 5

B19 B3 B17 B16 B15 B14 B13 B2 B5 B1 B11 B9 B8 B17A B4 B3A B16A B5A B14A B13A B20 RRP18 B5A B6 B12 B11A B9A B10 B8A B7 B18

HY2A HY20 HY8 HY7 HY6 SY2 HY16 HY21 D38 D39 HY11 HY9 HY12 HY10 HY24 HY23 HY17 HY1 HY13 HY14 HY15 HY4 HY18 HY19 HY1A RRP8 HY3 EN-1A EN4 EN3 HY3A EN-1 EN2 EN2A

HY2 HY5 SY3 HY27 HY26 HY25 RRP2 HY22 EC4 C1 C2 EC2 RRP20 EC7 EC3 B21 RRP4 RRP15 EC5 RRP19 PM12 EC6 PM1 PF 2 RRP1 RRP5 RRP6 PF9 PF8 RE1 RRP7 RE2 R2 R3 R4 PF11 PF12 PF13 PF14 PF7 RRP17 PF10 PF15 RRP21 RRP11 RRP23 RRP22 RRP24 RRP25 RRP26 PF4 PF3 PS1 PM8 PM10 PS4 PS2 PS3 RRP9 R1 PM3 PM6 PM2 PM4 PM7 PM5 PM11 PM9 PM13

PF5 DI SY1 D2 FM25 D3 PF6 D4 D5 D6 FM26 D7 RRP3 FM13 FM11 FM14 FM12 FM15 FM16 FM19 FM18 FM17 D21 D20 D19 D18 D17 D16 D15 SY6 FM1 FM2 FM3 RRP14

D14 D13 D12 D11 D10 D9 D8 FM24 FM23 FM22 FM21 FM20 SY7 RRP10

FC1 FC2 D33 D32 D34 D36 D35 D37 FC1A RRP16

FM5 FM6 D29 SY4 FM4 D31 D30 FM8 FM9 FM10 RRP13

D28 D27 D26 D25 D24 D23 SY5 FM7 D22 RRP12

KEY

ACTIVITY

NEAR CRITICAL PATHS

CRITICAL PATH

RESTRAINT

NODE, DENOTES START & FINISH OF AN ACTIVITY

ACTIVITY REFERENCE

Code	Category	Pages
SY	Survey	46 - 54
HY	Hydrology	55 - 84
EN	Environmental	85 - 90
EC	Economic Studies	91 - 100
R	Recreation	101 - 106
PF	Plan Formulation	107 - 124
PS	Power Studies	125 - 130
PM	Power Market Studies	131 - 146
FM	Foundations and Materials	147 - 174
D	Design	175 - 216
RE	Real Estate	217 - 222
C	Cultural Resources	223 - 226
FC	Field Camp	227 - 230
B	Biological Studies	231 - 256
RRP	Reports, Reviews, and Public Participation	257 - 284

SOUTHCENTRAL RAILBELT AREA, ALASKA

PROGRAM NETWORK & ACTIVITY SCHEDULE

ALASKA DISTRICT, CORPS OF ENGINEERS