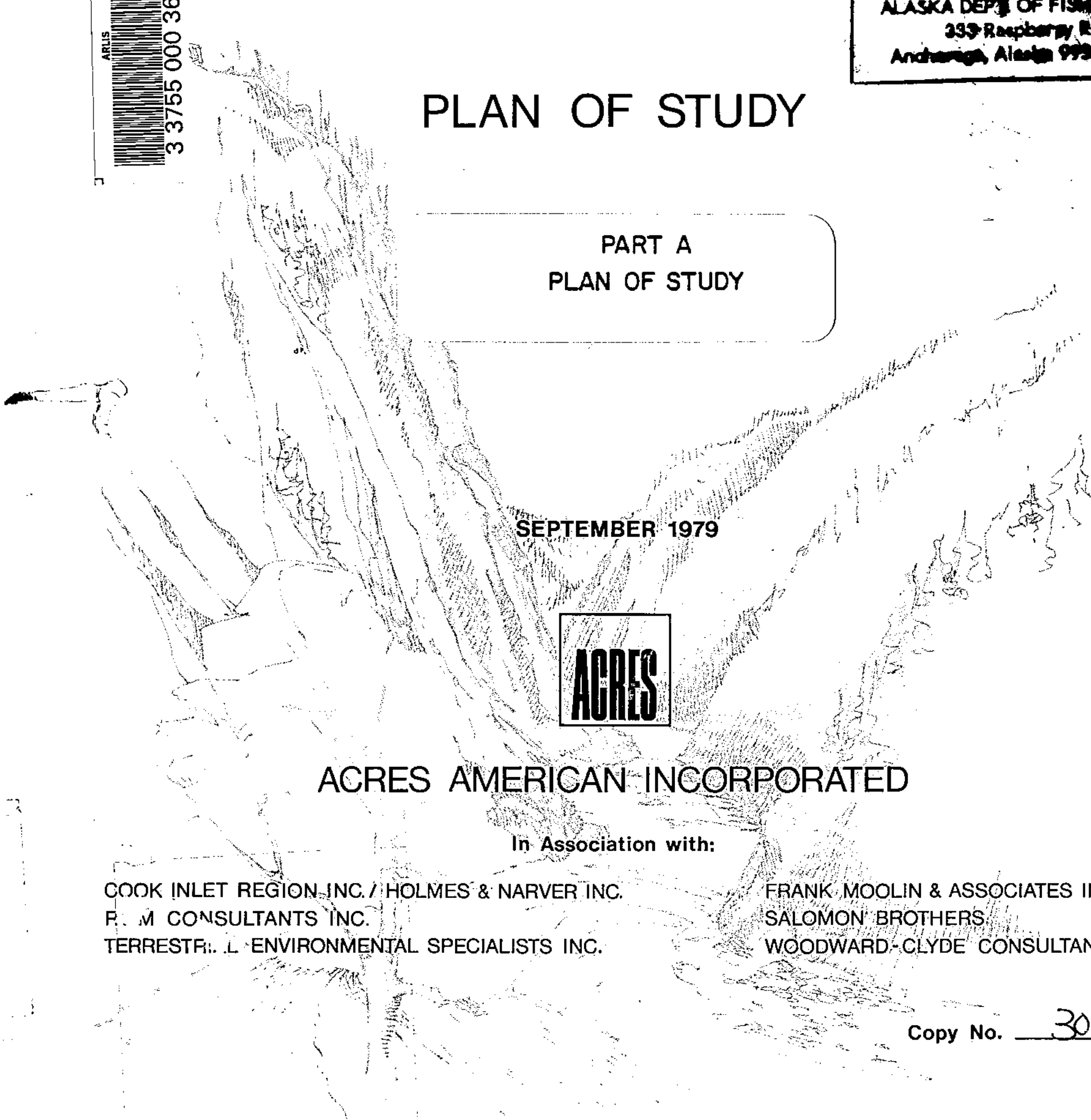
#391

ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY



PART A
PLAN OF STUDY

SEPTEMBER 1979

ACRES

ACRES AMERICAN INCORPORATED

In Association with:

COOK INLET REGION INC. / HOLMES & NARVER INC.
R&M CONSULTANTS INC.
TERRESTRIAL ENVIRONMENTAL SPECIALISTS INC.
FRANK MOOLIN & ASSOCIATES INC.
SALOMON BROTHERS
WOODWARD-CLYDE CONSULTANTS

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Copy No. 30

September 8, 1979
P5477.00

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

Dear Mr. Yould:

Susitna Hydroelectric Project
Plan of Study

In accordance with your request dated June 25, 1979, I am pleased to submit herewith our Plan of Study for a program of work leading to FERC license application for the construction of the Susitna Hydroelectric Project. The Plan of Study, which has been assembled in the format prescribed in your Request for Proposals, comprises the following component volumes:

- Executive Summary
- Part A - Plan of Study
- Part B - Implementation of the Plan of Study
- Part C - Volume CI; Supplemental Information
  - Volume CII; Company Experience
  - Volume CIII; Environmental Appendix

For your guidance, an overall Table of Contents has been included with each volume, in addition to the detailed volume indexes.

To prepare and implement the Plan of Study, Acres has assembled a first class team which we are confident will be fully responsive to the needs and requirements of the Alaska Power Authority in the successful completion of this and subsequent phases of the Susitna Project. This team is composed as follows:

Project management and lead architect/engineer:	Acres American Incorporated	Buffalo, NY and Columbia, MD
Geotechnical field studies:	R&M Consultants Incorporated	Anchorage, AK
Construction management:	Frank Moolin & Associates	Anchorage, AK
Environmental assessment:	Terrestrial Environmental Specialists, Incorporated	Phoenix, NY
Seismic studies:	Woodward-Clyde Consultants	San Francisco, CA Anchorage, AK
Financial advisors:	Salomon Brothers	New York, NY

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The Liberty Bank Building, Main at Court
Buffalo, New York 14202
Telephone 716-853-7525 Telex 91-6423 ACRES BUF
Other Offices: Columbia, MD: Pittsburgh, PA: Raleigh, NC: Washington, DC

Logistic support: Cook Inlet Region Incorporated/ Holmes & Narver — Anchorage, AK

This team can clearly demonstrate "hands on" proficiency in the planning and implementation of projects of the type and magnitude of Susitna; as overall team leaders, Acres American can draw upon the knowledge and experience gained for the design of more than ten major hydroelectric facilities in the northern environment having a total installed capacity in excess of eleven thousand megawatts.

The proposed Plan of Study, set out in detail in Section A5 of this submission, has been specifically aimed both to satisfy the License Application requirements of the FERC, and to generate the requisite information for the financial community. A carefully balanced and flexible study program addressing each of the key factors in the decision process, has been assembled with clear provision for proper participation by the public and for periodic review by the APA.

The total estimated cost of the study program leading to license application amounts to $19.7 million in 1979 dollars. An additional amount of $3.4 million is required to conduct effective public participation, financing and local project management programs and to satisfy certain non-discretionary funding requirements discussed in Section A.3 of this submission. Of the total, approximately 70% ($16.5 million) will be spent in Alaska through our Alaska Project Office located in Anchorage by the Alaska based team members, and through the various field operations required to provide the requisite technical and environmental data.

I believe that the Acres Team can provide the proper combination of experience and ability to successfully initiate this key first phase of this challenging project, and to follow through in the subsequent design and construction phases. A draft contract, which I would suggest provides the APA with the requisite level of protection and direction, will be found in Part C of this Submission. I look forward with confidence to your evaluation.

Yours very truly,

ORIGINAL SIGNED BY

D. C. Willett
Vice President and
Manager, Hydroelectric Divsion

DCW:ah

Enclosure: 4 copies of POS

Copies; As shown on attached distribution,
each with one copy of POS.

The contents of this proposal are provided for the sole use of the State of Alaska, the Alaska Power Authority, and such other agents of the Alaska Power Authority as may be designated to review and evaluate its contents. Proprietary information is contained herein. Unauthorized reproduction or disclosure of the contents, in whole or in part, to any individual or organization other than those specified, without the express approval of an officer of Acres American, is strictly prohibited.

ACKNOWLEDGEMENT

This Plan of Study could not have been produced without major contributions from each corporate member of the Acres team. Frequent cross country journeys, long hours devoted to preparation of inputs, and an unusual degree of effort from various administrative support staffs have together been instrumental in completing the assigned task--and much of the work has been an out-of-pocket expense for each corporate member. In addition to this enthusiastic support, however, a number of other individuals and organizations have cooperated fully and advised sagely.

The Alaska District, U.S. Army Corps of Engineers, has made available for our perusal all of the materials which have been collected to date in support of their own feasibility study and subsequent field exploration program. The genuine interest displayed by the District in providing this information and in offering many hours of explanation from already busy staff members is deeply appreciated.

A group of concerned citizens and representatives of environmental groups was kind enough to offer their time to express issues which they regard as important. The session spent with them was most helpful as we prepared plans for environmental studies in particular and for other tasks in general.

The Alaska Department of Fish and Game has met with us on a number of occasions. The thoughtful efforts of that organization in developing a program necessary to achieve project objectives and in discussing ways and means to achieve it without compromising ADF&G's own requirement for maintaining objectivity have been necessary and important.

The Federal Energy Regulatory Commission has been kind enough to provide us with advance information regarding possible regulatory changes soon to be promulgated.

Individual consultants who would serve as principal investigators for environmental studies and others who have agreed to become candidates for external review boards have been extremely helpful in laying out this plan.

The University of Alaska, through its various institutes and individual faculty members, has made its extensive capabilities known to us and has offered advice and assistance in planning for their use.

The Alaska Department of Natural Resources has provided a program to us for the conduct of certain in-stream studies for our consideration.

Discussions with various utilities during prior visits in November 1978, and subsequently have been helpful to our understanding of the power market.

The Alaska Power Administration has provided valuable information about power surveys, transmission line planning, and unique operational experiences at existing hydroelectric projects under their control in Alaska.

The Bureau of Land Management has offered coordination and explanations which will be useful in satisfying certain important permit requirements.

Staff members of other Alaska agencies such as the Department of Economic Development, Department of Commerce, and the Department of Environmental Conservation have kindly furnished us with statistical data and with vital information regarding plans for the future in Alaska.

The Fish and Wildlife Service and the National Marine Fisheries Service have offered advice to our environmental planners as the basis for understanding their roles in our satisfaction of FERC regulations.

We have been impressed with the professionalism displayed by the Alaska Power Authority in devising the program for possible selection of a private engineering firm and especially in their impartiality as they scrupulously provided assistance and advice to the various competitors in this exciting endeavor.

Other individuals and groups too numerous to mention have contributed as well. To all who have supported the Acres effort, sincere appreciation is extended. We are delighted to know that such a high degree of cooperation exists throughout the State of Alaska and within the organizations of others having interests there. Our confidence in our ability to successfully implement this POS has been enhanced immeasurably as a result.

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A1: PROGRAM OBJECTIVES

A.1.1 - Introduction

This Plan of Study has been prepared by Acres American Incorporated in response to the Request for Proposal issued on June 25, 1979, by Mr. Eric Yould, Executive Director of the Alaska Power Authority. It includes significant contributions from other firms who would generally be involved as subcontractors in the event that a contract to undertake the study itself is awarded to Acres American Incorporated. Major participants in the Acres team include R&M Consultants, Inc.; Woodward Clyde Consultants; Terrestrial Environmental Specialists, Incorporated; Cook Inlet Region Incorporated/ Holmes and Narver, Incorporated; Salomon Brothers; and Frank Moolin Associates.

The gestation period for giant projects tends to be long. Wild bursts of enthusiastic effort followed by periods of genuine apathy (or total despair, depending upon whose vantage point is selected) are common. Development of the Susitna River has so far followed that classic pattern.

As early as 1952, the Bureau of Reclamation published a report identifying a large number of potential hydroelectric power sites in Alaska, noting pointedly the strategic advantages enjoyed by the Susitna River because of its proximity to Anchorage and Fairbanks. Even then, Devil Canyon was perceived as the place to install a large dam. It was--and is--a steep, narrow rock walled canyon through which silt laden grayish waters swirl and churn and turn to white froth as they rush for the sea. Updates by the Bureau led to proposed authorization in 1961 of Devil Canyon and Denali--a site far up-river of Devil Canyon, astride extensive wet lands and marshy areas, where the Susitna draws strength from relative placidity before it attempts the inevitable plunge through miles and miles of canyons.

Another giant project was under active contemplation in the early sixties and its mind boggling size, together with the engineering challenges it offered, were especially exciting in a brand new state and during the space technology wars then being waged. The Rampart hydro project would have created a pool larger than the State of Connecticut if it had ever been built.

While the Rampart studies put the Susitna project in limbo for a while, a number of long time Alaskans worried about the risks of such a venture. As fate and thoughtful argument would have it, Rampart is unlikely to be built at any time in this century.

Susitna was delayed long enough, though, to allow for discovery and development of then economical natural gas production. By the time the warnings of energy doomsayers were beginning to be heard and felt in 1973, the Susitna project once again began to appear attractive. The Bureau of Reclamation updated its earlier studies in 1974, recommending a four dam system, and the U. S. Army Corps of Engineers launched a major pre-feasibility study which led to a recommendation in 1976 by the Chief of Engineers that the Susitna Project be authorized. The Corps plan recommended two high dams, the first of which would be built as a massive earthfill gravity structure 810 feet in height at the Watana site more than

30 miles upstream of Devil Canyon. The second Corps dam was to be 635-foot high thin arch concrete structure which would sweep across the canyon from rock abutment to rock abutment -- essentially the same as the Bureau's Devil Canyon proposal.

By June 1978, the Corps of Engineers had prepared a Plan of Study requiring 24 million dollars and offering a program leading to completion of a detailed feasibility study. Further investigations by the Corps confirmed the adequacy of the Watana site, though they did reveal that some changes were required in particular for the spillway arrangement. As the situation now stands, provided that the necessary appropriations are made, the State of Alaska could choose to proceed along a course of action which leads to a study undertaken by the Corps and reimbursed by the State. A unique risk protection feature would permit the return of State funds in the event that feasibility is not shown.

The alternative to further federal involvement in the Susitna project is a scenario which includes selection of a private engineering firm as the State's consultant. Qualifications have been reviewed by the State for all those interested firms with strong hydroelectric development capabilities and three have been engaged to prepare a Plan of Study detailing the steps necessary to permit filing a license application to the Federal Energy Regulatory Commission (FERC). This Plan of Study describes a series of tasks and subtasks, along with reasons for these, as well as providing information regarding organizational matters and team qualifications.

A.1.2 - Primary Objectives of Study

(i) Establish technical, economic and financial feasibility of the Susitna Project to meet future power needs of the Railbelt Region of the State of Alaska.

(ii) Evaluate the environmental consequencs of designing and constructing the Susitna Project.

(iii) File a completed license application for the project with the Federal Energy Regulatory Commission.

A.1.3 - Specific Objectives of the Study

To meet the primary objectives of the study, the following specific objectives are proposed:

(i) Determine the future electric power and energy needs of the Southcentral Railbelt Area.

(ii) Assess alternative means of meeting the load requirements of the Railbelt Area.

(iii) Prepare an optimal development plan for the Susitna Project wherein power costs and probable impacts are minimized, safety is enhanced, and financing is achievable.

(iv) Establish a definitive estimate of the total cost of bringing power on line, together with a statement of cash flow requirements.

(v) Evaluate the physical, economic, and financial risks of the Susitna Project and determine ways and means to avoid or minimize their consequences.

(vi) Evaluate existing environmental and social factors as they now exist in the proposed project area, assess the impacts of the proposed project, enhance environmental values to the extent possible, and recommend mitigating measures.

(vii) Estimate the annual system power costs in the Southcentral Railbelt Region with and without the project, study the integration of Susitna power into the Railbelt utility systems, and assess power marketability.

(viii) Prepare a complete license application and file this with the Federal Regulatory Commission.

(ix) Ensure that the needs and desires of the public are known, keep interested parties and the public informed, and afford an opportunity for public participation in the study process.

(x) Determine an optimal program for achieving financing, including resolution of issues regarding tax-exempt status of bonds which may later be offered.

(xi) Minimize the financial risks and expenditures which must be incurred by the State of Alaska in pursuit of the above objectives should development of the Susitna Project prove to be not in the best interests of the State.

(xii) Maximize opportunities for equal employment opportunities for Alaskans and for involving in the work members of those Native Corporations in the region.

A.1.4. - Primary Aspects for Susitna Requiring Study

(i) Introduction

As with any major hydroelectric project, the number of investigations and substudies required to achieve the primary objectives noted in paragraph A.1.2 above is significant. Each of these requirements is described in terms of precise tasks and subtasks in Section A5. Even so, a number of primary aspects, particularly insofar as they address major concerns, deserve to be highlighted. Thus certain key areas of the study are highlighted in succeeding subparagraphs.

(ii) Power Studies

While this Plan of Study had necessarily to be written on the assumption that project feasibility will in fact be demonstrated, we are well aware of the importance of demonstrating that a need for significant increases in power generating capacity does truly exist in the Railbelt Area and that this need can best be satisfied by the Susitna Project. Indeed, it is clear that the absence of need or the discovery of a better means of satisfying it if it exists will represent prima facie evidence that development of the project is not in the best interests of the State. Power studies will be undertaken to examine and define a range of load forecasts and to assess possible alternatives or groups of alternatives which together could satisfy the projected demand.

We will avail ourselves of intimate knowledge of Alaska in general and the Railbelt in particular through employment of the Alaskan office of Woodward-Clyde Consultants (WCC) to undertake load forecasting studies. WCC in turn has arranged for consultation from the University of Alaska, particularly for use of their econometric models. The study of non-hydro alternatives by WCC (reviewed by Acres' Thermal Power Division) and of hydro alternatives by Acres will be enhanced through use of the General Electric Optimum Generation Program, Series V (sophisticated computer models designed to permit multiyear analysis of generation system mixes) which we have successfully used in the past for a comprehensive study of alternatives to the Dickey-Lincoln School Lakes Project in New England.

(iii) Financing Plan

Successful financing of giant projects is inevitably a complex and time-consuming task. Our own expertise in this area, as evidenced by participation in the successful financing of the Churchill Falls Project where Mr. J. G. Warnock managed the team responsible for bond support documents, will be available to our financial consultants, Salomon Brothers. This well known investment banking firm has managed or co-managed 655 issues of tax-exempt bonds in the total amount of $48.3 billion since January 1, 1974. Dr. C. P. Chapman will manage risk analysis studies. His unique special capabilities in that area have been demonstrated time and again for large projects including some in subarctic environments.

(iv) Ice Engineering

The study of ice engineering has necessarily been an important part of Acres' efforts for past projects in recent years. Our successful involvement in hydroelectric projects throughout North America, with a total installed capacity of over 14,000,000 kW, is a matter of record. Assistance in ice engineering studies will be provided as well by R&M whose hydrologic investigations of rivers and streams throughout Alaska has been significant. Our conceptual designs for minimizing the problems associated with frazzile ice, ice jams, ice shelving and the like will be subjected to exhaustive modeling after license application has been made and during the preparation of detailed designs. Problems associated with permafrost are also familiar to the Acres organization: our staff have extensive experience in developing unique and effective methods of dealing with such problems in connection with large power projects in subarctic regions.

(v) Earthquake Engineering

Of the many potential risks associated with the Susitna Project, those associated with seismic problems are probably the most significant. Certainly, no single area of concern is likely to have more immediate catastrophic consequences if the engineering work has not been done thoroughly and well. Not only is it important to design all structures to survive unscathed in the event of an earthquake, but it is also essential to determine the extent to which creation of reservoirs on the Susitna River will itself induce earthquakes.

Our approach to this problem is twofold: first, we have engaged the services of the California office of WCC to undertake extensive seismic studies. WCC has operated in Alaska for over ten years and has amassed a considerable data base on geological and geotechnical conditions, faulting, and seismicity of the Anchorage and Railbelt Areas. WCC have also had extensive seismic experience with major dam and power projects elsewhere. Second, we have recommended a list of eminent professional engineers whose accomplishments are recognized worldwide as the basis for selection by the Power Authority of one or more external review boards. The engineering board would be provided funds on the order of $1 million with which to undertake confirmatory or additional seismic studies. Acres would offer coordination services and administrative support, where appropriate, to the board(s), but authority to select, remunerate, terminate and to direct their activities would remain with the Power Authority.

(vi) Project Management/Construction Management

In order to provide Alaskan-experienced project and construction management capability in the POS team, Acres will combine with its in-house resources the additional resources of the Frank Moolin and Associates, Inc. organization. This company presently operates out of Fairbanks, Alaska and provides executive project and construction management experience to the energy industry. The Moolin team provides many years of "hands-on" experience on varying sizes and types of projects, including recent responsibility for construction of the Trans-Alaska Pipeline, a $4.2 billion effort. Members of the organization provide an unusual, multi-disciplined, combination of energy, industry and heavy construction experience. In addition, conditions unique to planning, managing and constructing projects on the Alaskan scene are familiar to all of these individuals.

A2: STUDY APPROACH

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SECTION A2 - STUDY APPROACH

A.2.1 - Discussion of Problems to be Resolved

(i) Introduction

In formulating a logical approach to study of a major hydroelectric development in a relatively hostile climate and environmentally sensitive region, it is necessary to identify the particular problems which must be addressed and to place these in proper perspective with the more routine elements of technical and economic feasibility assessment. The objective is to arrive at an optimal development which recognizes and allows for all constraints imposed, and addresses such vital issues as environmental acceptability at the proper stage to allow it be considered adequately through public participation and other processes to satisfy licensing procedures. The financial viability of the project is, of course, also a vitally important consideration which lies beyond the strict technical and economic parameters of the proposed development. The approach taken in the overall studies must lead to a confident determination of the financiability (or otherwise) of the project.

We have identified a number of potential problem areas early in our planning efforts as the basis for ensuring that the final Plan of Study will provide adequate measures for dealing with them.

(ii) Optimal Development

Millions of dollars have been spent to date in an effort to determine just which of many concepts will lead to optimal development. Optimization, like beauty, though, is in the eyes of the beholder. The Bureau of Reclamation selected a four dam system to be established on the Susitna River. The Corps of Engineers has succeeded in obtaining authorization to conduct detailed feasibility studies for a two dam system which would provide essentially the same amount of power as that for four dams of lesser height. The Corps approach benefitted from the Bureau of Reclamation's work and built upon it. The Acres approach will continue that refinement process. In so doing, though, it must account for certain potential problems:

(a) Load Forecast Accuracy

There has been a nationwide slackening of historically high load growth rates for electric utility systems since the energy crisis of 1973. It can no more be assumed that this trend will continue throughout the next decade or two than it can be assumed that longer term historical patterns will once again assert themselves. We must, nonetheless, develop load forecasts in whose accuracy a high level of confidence can be placed.

(b) Alternatives to Susitna Development

Implicit in the search for optimal development is the identification of all reasonable alternatives. We must acquire strong and reasonably definitive knowledge of alternatives to the Susitna Project for satisfying projected load forecasts.

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(c) Alternatives for Development of the Susitna River

In the event that no alternative to Susitna Development is found to be superior in terms of technical, economic, and environmental considerations, we will need to assure the Power Authority that the Corps of Engineers concept is the most appropriate. The days when a simple economic test led to plan selection have long since passed.

(iii) Data Acquisition

Significant portions of the total cost of the Plan of Study are devoted to the acquisition of additional data. Field studies in the areas of survey, geotechnical, hydrology, environmental, seismicity, and transmission will demand a base of support and proper means of site access and egress in addition to time and equipment for the purpose. Certain important problem areas include:

(a) Seasonal and Weather Constraints

Most data collection will have to be accomplished during relatively short summer seasons, resulting in high peak loads on camp facilities (a major consideration in the Logistical Plan in Section A4) and in particular on demands for certain equipment (including drilling, special survey, gaging, seismic instruments) not necessarily in great abundance in Alaska--at the very time that other projects in the State simultaneously require like items.

(b) Study Period

The relative brevity of the proposed 30 month study period does not allow for training personnel to operate in a relatively harsh sub-arctic environment.

(c) Coordination of the Program

The variety of investigations conducted at the same time in the same general area and subject to severe, albeit important, land use restrictions demands an unusual degree of coordination and management of the data acquisition effort (see also (ix) below).

(iv) Financial Risk

It must be recognized at the outset that several aspects of the Susitna Hydroelectric Project will inevitably imply substantial risk to potential investors. It will be necessary, therefore, to address all real and perceived risks with a high degree of intensity, limiting or disposing of as much of the exposure as possible to build a realistic level of confidence in the project. There will, no doubt, be residual risks for the potential investor to consider but attitudes to these will be significantly affected by the way in which the Alaska Power Authority can demonstrate that all potential problems have been diligently examined and fully addressed.

(a) Superposition of a Large Project on a Small System

In the case of Susitna, a very major, capital intensive project undertaking is being considered for addition to an existing utility base of relatively limited facilities and fixed assets. The financial approach must therefore be on the basis of Project Financing where funding is raised on the assured revenue and cash flow generated, usually, from a long term sales contract, in this case for purchase of power and energy.

(b) Risk of Meeting Anticipated Power Output

The nature of the financing approach has a bearing on many aspects of the overall study plan for Susitna. It requires, for instance, that hydrological and energy assessments are made with a particularly high level of confidence and that risks of shortfall are carefully examined.

(c) Design Risks

A high level of confidence must be achieved in the adequacy of engineering design and in the construction costs involved in meeting the requirements imposed. The estimates should be at a level allowing for a relatively high likelihood of an "under-run" on total costs including contingency provisions. The most careful judgement must be applied to assessing likely increases in material, labor and equipment costs to allow for confident definition of a provision for escalation.

Construction and contracting practice must be evolved which avoids or even eliminates over-run exposure. These and many other aspects of the plan for development must be all the more intently addressed to meet the need of a project of the nature of Susitna.

(v) Design Problems

Our own experience in planning, design, and construction management of large engineering projects in North America and particularly in sub-arctic environments has made us acutely aware of certain design problems which must be addressed early in the process of total project development. These include:

(a) Seismicity

The Susitna River flows in a region of known high seismic activity. Acquiring knowledge of the precise nature and extent of this activity must necessarily be a prelude to designing earthquake resistant project features. In addition, the question of the effect of large reservoirs on the Susitna River in stimulating earthquakes must be studied in some detail. Because of the potential for catastrophe, careful and thoughtful evaluations of seismic efforts by others appears to be necessary.

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(b) Ice

It will be necessary to ensure that icing problems do not interfere with operation of the completed hydroelectric project as well as to determine how downstream ice conditions with the project will differ from those without. The effect of ice shelving in the reservoirs or ice jamming must also be addressed.

(c) Slope Stability

The nature of the project area is such that proposed reservoirs tend to be long and narrow. Landslides, avalanches, and side slope failures are especially to be guarded against.

(d) Siltation

It will be necessary to consider the rate at which sediment load fills dead storage space in the upper reservoir of the system, for the risk of losing energy production due to losses in active reservoir storage must be eliminated. Downstream of any dams, the effect of changes in sediment content will require evaluation as well. In the latter evaluation, it will be important to determine the extent to which relatively clearer sediment starved summer flows will pick up additional load from the river bed downstream.

(vi) Environmental Impact

There is no doubt that the level of effort to be applied to environmental studies is necessarily significant, for little is known of the total environmental resources in the project area and the superposition of a giant project on the Railbelt will have social consequences which must be determined. Certain problem areas of note include:

(a) Complete Cycle Studies

Definitive evaluations in the environmental area frequently require successive multi-season data acquisition efforts. In the case of the fishery resource, for example, a five year program is indicated. Yet, license application is scheduled less than three years hence.

(b) Getting up to Speed

The unique nature of the environment in the project area is best studied by those who have earlier gained familiarity with sub-arctic regions in general and Alaska in particular. The correct individuals must be identified lest lengthy training periods consume valuable study time.

(c) Relationships with ADF&G

We recognize the great expertise of ADF&G in certain areas and we believe certain environmental studies can best be accomplished if undertaken directly by ADF&G. Even so, it is imperative that the necessary review, evaluation and approval function which ADF&G must also perform be objective. Procedures must be worked out to preserve this objectivity.

(d) Information Exchange

As environmental data is collected and impacts are assessed, it will be necessary to ensure that provisions are made for information exchange and for contributions from the many interested individuals and groups whose particular focus will be on environmental issues.

(e) Interpretations of NEPA

A major battleground in the recent past between project proponents and opponents has been the National Environmental Policy Act. Major projects in the past would almost certainly travel a route of court litigation to determine compliance with the Act. The litigation has centered upon the Environmental Impact Statement, FERC application Exhibit W. The recent council on Environmental Quality's Requirements for Environmental Impact Statements should clarify the review process at the Federal level; however, problems still exist in agency interpretation and between the state and federal governments.

(f) Mitigation

The Fish and Wildlife Coordination Act requires that an applicant coordinate with Federal and State fish and game agencies to prepare a fish and wildlife plan. The plan is included in the license application as Exhibit S. Exhibit S will contain essentially a mitigation plan for the adverse impacts which project development will have upon the existing wildlife resources in the project area. Considering the pristine setting of the project area and migratory and habitat patterns of such resources as caribou herds and moose, development of and agreement on the mitigation plan will be a major effort in project development. The FERC must resolve disagreements on the adequacy of the mitigation plan prior to issuing a license. A great deal of time can be involved in the series of correspondence, meetings or formal hearings if needed to resolve the conflict.

(g) Conflicting or Overlapping Authorities

Along these same lines are compliances with the Anadramous Fish Act and the Endangered Species Act. As these acts are administered by different agencies (Fish and Wildlife Service and National Marine Fisheries Service, respectively), approval by one does not necessarily ensure approval by the other. For example, method of a fish transportation (if required) around the dam may not be acceptable to both agencies. Proposed operation of the reservoirs may also fall into conflict over maintenance of minimum downstream release and fluctuating release volumes.

(h) Historic Preservation Concerns

Exhibit V of the license application requires the applicant to show consultation with the Advisory Council on Historic Preservation and the State Historic Preservation Officer to assure that no historic or cultural sites will be adversely affected. Numerous problems could be associated with this aspect should such sites be uncovered.

(vii) Licensing

Prior to constructing the Susitna Hydropower Project, extensive coordination and consensus agreements must take place between the project developer and numerous Federal government agencies. Several permitting processes will need to executed. However, the focal point of the efforts will most probably be the preparation and action relative to the Federal Energy Regulatory Commission (FERC) license application. The license would allow the applicant to construct and eventually operate the proposed facility for a period of up to 50 years. The licensing process is fairly complex as noted by the fact that the current average major license review time is approximately seven years from time of application to approval.

(a) Complexity of Review Process

The reason for the length of time and complexity of review lies in the fact that the FERC and the reviewing agencies have a number of requirements under existing statutes which must be satisfied prior to taking action upon an application. Additionally, the statutes, under certain circumstances, provide conflicting authorities between review agencies and the FERC.

(b) Intervenors

Compounding the review difficulty is the special status of intervenors in the process. The FERC's authorization laws and administrative practice give enormous powers to the project intervenor to delay the process with a series of hearings on legal questions pertaining to project licensing. Essentially, the burden of proof of compliance with the listed statues will fall upon the developer.

(c) Land Rights Issues

Even at this stage of project formulation, several pitfalls within the licensing process can be foreseen. Land rights for construction and access to the project could be a problem, particularly with the complexity of the Alaska native land rights, and use of federal lands under the Federal Land Policy and Management Act. At this time, the U. S. Departments of Interior and Agriculture are developing regulations for administering the Act. As the regulations will be relatively new during planning and development of the Susitna project, administrative and legal problems associated in compliance with the Act can be expected.

(d) Water Resource Development Plan

Section 10(a) of the Federal Power Act requires that the project be best adapted to a comprehensive water resource development plan for the project area. In the case of the Susitna project, compliance will mean that the need for the project and all alternatives to the project have been carefully studied to determine that this development is indeed in the best interests of the public.

(e) New Regulations

We have determined that FERC will shortly issue new proposed draft regulations for licensing a major hydroelectric project. It will be necessary to review new procedures and respond to required changes while the planned study is in progress.

(viii) Problems in Public Participation

There is a distinct difference between the concepts of public information and public participation. The former is designed to let the public know what is happening (sometimes, unfortunately, to let the public know only what the planner wants it to think is happening). The latter not only includes public information as a subset, but also provides a means for the public to become involved in and influence the course of work. For an effort as large as the Susitna Hydroelectric Project and with impacts extending effectively into perpetuity, public participation--including accurate public information-- is an imperative. The attendant problems are significant:

(a) Conflicting Interests.

Taken alone, the motivations and objectives of individuals and organizations who have been involved to date on the Susitna Project are generally sincere and relatively easily understood. Considered collectively, however, they represent clear conflicts. It follows that it will be virtually impossible to satisfy every desire. Problems will almost certainly arise in determining what heirarchy of concerns is to be established. How will federal interests in accelerated development of energy resources be reconciled with those of citizens who would preserve the Alaskan quality of life? Recreational interests in preserving a natural river with those of consumers who seek ways and means to stabilize the cost of electric energy? The following list of special interests is not exhaustive:

-- Utility interests, including concerns about ability to meet energy demands, prospects for recovery of capital investments, profits for investors.

-- Alaskan native groups, particularly those which have selected lands in the Susitna River Basin.

-- Fisheries industries whose concerns about impacts on future catch, particularly of anadromous fish, have not yet been fully addressed.

- -- Downstream residents concerned especially about changes the Susitna Project will impose upon their way of life.
- -- Consumers of electric power in the Southcentral Railbelt.
- -- Marketers of alternative energy resources.
- -- Conservationists who perceive the Susitna Project as likely to spur unwanted growth.
- -- Industrial and commercial interests who perceive stabilization of energy costs as important to future progress.
- -- Unemployed workers interested in opportunities arising directly or indirectly from construction of dams on the Susitna.
- -- Agencies charged with maintenance and preservation of Alaskan wildlife, including in particular the Alaska Department of Fish and Game and the Federal Fish and Wildlife Department.
- -- Railbelt residents who seek assurances that a Susitna Project will neither induce earthquakes nor fail catastrophically if one does occur.
- -- And others.

(b) Impacts on Schedules

A proper public participation program necessarily requires that provisions be made to permit time for review and comment at various points as the study develops. Accommodating review time requirements, particularly in cases where proceeding on a new task depends upon a favorable decision having been made on results of the previous task, can serve to delay scheduled completions.

(c) Changing to Accommodate the Public Interest

True public participation requires not only that the public be informed and that they be allowed to offer comment, but also that their legitimate inputs be incorporated into the work. Thus, provisions must be made to properly address new issues as they arise and to take action where required. It is almost inevitable that an effective public involvement program will require that the plan of study be dynamic. An increased risk that costs will be incurred and scheduled completion times will be extended as new courses of action are pursued must be regarded as a problem area.

(d) Communications in Alaska

The large area over which power would be distributed, relatively undeveloped road nets, and remoteness of many of the areas to be affected by the Susitna Project combine to create unusual pressures on effective communications. It follows that any proposed public participation program must be designed to afford reasonable involvement opportunities even for those who have no practical means to attend meetings or make regular visits to information centers in large metropolitan areas.

(ix) Control and Coordination

We have assembled a team whose individual corporate members bring strong special skills to bear upon satisfaction of the various project objectives. The danger associated with such an assemblage is that control and coordination problems increase in complexity as a result. It becomes important then, that early steps be taken and procedures established so that the synergism promised by putting the team together is not lost through failures in management. Two areas in particular are worthy of consideration:

(a) Planning, Control and Management of the Study Itself

Provisions must be made to avoid costly redundant efforts as well as to ensure that each and every task and action is budgeted for and accomplished.

(b) Planning the Eventual Construction Program

The matter of timely and efficient constructability of a proposed major project can be an extremely costly problem area if it is not attended to throughout the planning and design process.

A.2.2 - Proposed Approach to Solution of Problems

(i) Introduction

Given the size and complexity of the proposed project, it should come as no surprise that the problem areas noted above and others as well demand carefully developed, often innovative, solutions. In general we believe a certain pervasive discipline must be a part of our approach to the project as a whole and to each of the necessary tasks and subtasks individually.

Briefly stated, we recognize a series of steps as virtually universally applicable:

(1) Define the problem
(2) Establish objectives
(3) Describe the work necessary for achieving the objectives at minimum cost
(4) Assign responsibility to the appropriate team or subteam leaders
(5) Ensure each leader has sufficient qualified persons to do the work
(6) Make the necessary physical resources and logistic support available
(7) Schedule the activities to ensure resource commitments and overall project schedule are appropriate
(8) Collect the necessary data
(9) Evaluate the data
(10) Draw conclusions
(11) Provide expert review
(12) Define new problems
(13) Establish flexible procedures to permit rescheduling and new resource commitments as necessary when new problems or scope changes arise.

While these steps will apply in general, certain specific comments as regards problems identified in paragraph A.1.1 above are noted in succeeding subparagraphs below.

(ii) Optimal Development

(a) Load Forecast Accuracy

The business of predicting the future inevitably involves varying degrees of uncertainty. We plan to reduce this uncertainty to an acceptable level through the use of proven analytical econometric models developed in the State at the University of Alaska precisely to support the type of predictive efforts required. WCC (Alaska) will lead this work, supported by Professors T. L. Husky and O. S. Goldsmith. We will establish a range of forecasts together with assumptions associated with their development. This approach will, of course, allow us to test the implications of various growth scenarios on project viability and timing, as well as permit evaluation of reasonable alternatives.

(b) Alternatives to Susitna Development

Definition of reasonable alternatives demands that a marriage of appropriate technical knowledge of each alternative to intimate knowledge of Alaska be accomplished. Acres has strong hydroelectric experience as well as a large thermal power development group. WCC (Alaska) furnishes capabilities in analysis of non-hydro alternatives as well as an Alaskan presence. Our intention is to study the widest possible range of alternatives and to test various combinations which might satisfy load forecasts. This testing process will be facilitated through the use of sophisticated computer models which we have used in prior alternative studies of major hydroelectric projects.

(c) Alternatives for Development of the Susitna River

While much time, effort and thought has gone into the earlier Corps of Engineers studies, we will nonetheless take a fresh look at possible alternative ways of developing the Susitna Basin. These studies will include, for example, consideration of a long power tunnel extending downstream from the Watana site. Our project team includes a number of personnel who are skilled in the art of hydroelectric planning and we have included a Concept Planning team within our Feasibility Studies task force.

(iii) Data Acquistion

We recognize the requirement for large field investigating teams. It follows that proper field support facilities will be necessary. Our logistics plan at Section A4 provides details in that regard. The matter of equipment demands in Alaska is a serious one. Not only must the proper type of drilling, measuring, instrumenting and sampling devices be available when and as needed, but also they must in many cases have been modified to permit use in remote sub-arctic regions. R&M is the only organization of its kind in Alaska. R&M's special surveying and drilling equipment and extensive Alaskan experience contributes much to our confidence in our ability to complete the proposed work on time and on schedule. In addition, most other principal investigators have had extensive experience in sub-arctic environments and all have made preliminary arrangements for equipment needs. Coordination will be facilitated through the establishment of an Alaskan project office headed up by a senior Acres engineer who has himself led similar efforts in the past for major projects in Canada.

(iv) Financial Risk

We have chosen the investment banking firm of Salomon Brothers whose strong experience in tax-exempt bonding matters will be extremely important in preparation of plans for successful project financing. Mr. J. G. Warnock's own successful experience as the leader of the bond documentation team on the Churchill Falls project provides an important strength on the Acres team. The study effort for financial planning will be shared equally by Salomon Brothers and Acres. In addition, we have planned an extensive risk analysis program for ensuring that we identify and minimize various financial and design risks. Certain special considerations pertain:

(a) Multidisciplinary Involvement

It will be clear that to deal adequately with the matter of financial risk it has to be considered from very many viewpoints inevitably involving a multidisciplinary approach.

Traditionally, engineers alone were engaged in the early planning and consideration of hydroelectric power sites with other interests - such as financial, insurance, labor relations, etc. - joining in later when feasibility had all but been established. Such a procedure was quite practicable when hydroelectric sites clearly justified development on their own merit, economics were not in question, and environmental constraint unheard of. Nowadays, despite rapid escalating costs of fuel generated power alternatives, hydroelectric power generation is often marginal in power supply economics and development faces constant uncertainty as to whether any installation could be justified at all in the face of environmental constraint and objections.

Into this aura of uncertainty major projects such as Susitna are being launched. It is clear that only the highest standard of management and dedication to an ultimate belief in proper development of renewable resources will lead such a project to implementation. Methods and approaches are, however, available and well tested which will assist the process markedly. Basic to the successful approach is a broad interdisciplinary involvement from the start. Engineers must be effectively backed up by a team of financial specialists, economic analysts, environmentalists, insurance experts, construction managers, labor relations men, etc. No longer is it practical for a single engineering discipline to carry a project from initial concept to commitment to construction in a program of relatively isolated concentration on the physical aspects of the site.

We advocate, therefore, a most carefully planned close involvement of the engineering team with all the other disciplines and specialists which, when integrated to a sum of effort over the preliminary phases of a project, can build the basic confidence which overcomes the apparent and growing constraints. Fundamental to the approach we recommend, is a close integration of engineering, financial and insurance speciality input from the start.

(b) Technical/Economic Relationships to Power Contract Negotiations

Fundamental to the success of any plan to develop the Susitna project is the focus of contract for the sale of energy and capacity from the completed plant. In order to provide the adequate debt service a contractual arrangement is necessary which calls for "take or pay" obligations on the part of the energy purchases. This and other basic elements of the power contract can have a profound effect on the viability of the project.

It might be suggested that this is not an engineering problem but one for the marketing/utility negotiation team alone. But not necessarily so; it is the engineer who can contribute vital knowledge to the assessment of the reliability of energy supply over the years of the contract. He also has to balance the values of various capacity factors for the planned plant. He has to assess, furthermore, the changing role that may be attributed to the facilitation as time passes into the future. It is necessary to view power system planning on a "dynamic basis."

Economists play their succinct role too. Much of the forecasting of likely market conditions falls to their judgement. They have to assess likely future variations in fuel and energy aspects of alternative generation. Cost escalation on construction has a heavy bearing on a hydroelectric project and is amenable to careful judgement by economic specialists.

(c) Risk Assessment and Contingency Planning

In order to protect the project capital structure, allowances have to be made for contingencies, provisions for escalation in costs and for a completion guarantee. The first two of these items are basic elements of the capital cost budget while the third is usually dealt with as a standby financing arrangement. In arriving at prudent allowances for contingencies on very major projects, it is becoming increasingly desirable to determine these as a result of a carefully conducted risk analysis. Modern methods are available, which have been adequately tested on large undertakings, to determine the likely confidence level of estimates both of costs and schedule (which itself has cost implications).

The approach planned for Susitna would employ up-to-date techniques of risk assessment and contingency planning which on the one hand would permit the reduction to a minimum of "real money" over-run allowances and employ to the maximum extent possible measures to mitigate risk.

The study contributes substantially to the determination of the "residual risk," which, in a project of the nature of Susitna, remains to be covered by insurance or by a conscious acceptance by the owner that it will be covered in some other way should adverse circumstances prevail. The capacity of the international insurance market method to assume greater levels of insurance has improved as the size of major projects has increased. The type of approach recommended is intended to lead to the most favorable practicable basis for insurance provisions.

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(v) Design Problems

Special design problems demand special attention, for time and effort devoted to their resolution prior to construction pay handsome dividends in terms of correction costs avoided later and in terms, as well, of securing the necessary degree of confidence on the part of investors, environmental interests, State authorities, and the public in general.

(a) Seismicity

We have noted earlier the importance of seismicity studies and of designing earthquake resistant structures. So important do we regard this area that we have planned for exhaustive investigations supported by modern sophisticated instrumentation. Acres has dealt with seismicity issues with great success in the past on a number of major hydroelectric and other power projects. WCC (California) will conduct the seismicity studies for the Susitna Project, with careful review provided by the Acres team. While the WCC expertise in this area is unquestionable, we have been particularly careful to provide the means and the resources to seek confirmation by objective learned experts whose duties will be conducted quite apart from the Acres team. In accordance with APA's expressed desires for a level of effort of $1 million to be applied to an external seismicity investigation, we have chosen an approach which calls upon a proposed external board (or boards) to invest that sum in those confirmatory or additional studies which they regard as essential to rendering an expert opinion on how well our own designs are responsive to earthquake concerns.

(b) Ice

Ice studies are provided for in the study program to assess the current icing conditions found naturally in the Susitna basin without the project. Field investigations and surveys will also produce vital information, including appropriate in-stream hydrographic surveys and flood plane cross-sections downstream of the proposed dam sites. As design concepts are evaluated, we will draw upon the expertise of members of the Acres team who have countered operational icing problems on past projects. In this regard, for example, our mechanical engineering staff will pay particular attention to the possibility that frazzile ice may interfere with generation flows. A separate Ice Studies team has also been included within our Feasibility Studies organization. The nature and extent of the potential for ice jamming and ice shelving in the reservoirs will be detailed and close coordination will be maintained with those involved in environmental studies to ensure that impacts of ice formations on wildlife migration and survival are understood.

A representative list of major projects undertaken by Acres in northern and sub-Arctic regions of North America is presented in Section C6, Volume II of Part C of this POS.

(c) Slope Stability

Field investigations by R&M will provide a source of data for evaluating slope stability. The extent of permafrost in the dam and reservoir areas and the resulting potential for slope instability will be carefully investigated by the Project Team. The combined expertise of R&M and Acres will be directed toward the design of countermeasures as appropriate and risk studies will consider the consequences of unanticipated slope failures and snow slides.

(d) Siltation

Earlier Corps of Engineers studies have indicated that the deposition of sediment in the Watana reservoir will be entirely in the dead storage area throughout the proposed operating period for the project. We will conduct necessary studies to confirm those earlier findings and to better determine the expected rate of siltation. Changes in silt load patterns downstream of the dams will also be examined from both environmental and water quality standpoints.

(vi) Environmental Impact

Our overall approach to a proposed extensive environmental program relies upon the coordination of a series of individual studies conducted by individuals whose entire professional careers have been devoted to particular subject areas. A number of consultants, several with considerable sub-arctic and/or Alaskan experience in pertinent areas of study, will participate in the work. The coordination effort will be accomplished primarily by TES whose own staff will augment the consultants' efforts. Certain specific matters highlighted above as problems will be resolved as follows:

(a) Complete Cycle Studies

The comprehensive program recommended by ADF&G is well conceived and is consistent with our own evaluations of the level of effort needed in important fish and game studies. The fact that the program extends beyond the proposed point for license application need not represent a deterrent, for our discussions with Mr. Ronald Corso of FERC have indicated that, provided the application itself describes what continuing studies will be conducted, it can be filed before they are completed.

(b) Getting up to Speed

Selection of consultants and, in appropriate areas of study, of ADF&G to perform base-line data acquistion work has been accomplished based on the criterion that each of the principal investigators must have experience in sub-arctic environments, preferably in Alaska.

(c) Relationships with ADF&G

Our approach to the issue of ensuring the ADF&G maintains its proper status as an objective reviewing and approving authority while concurrently undertaking investigatory tasks involves a unique concept. Each of the field studies and reports to be produced by ADF&G will be produced for and funded directly by the Power Authority. None of our organization charts or concepts includes ADF&G as a subsidiary or subcontractor to Acres. ADF&G's involvement is assumed to occur in accordance with the following scenario:

(1) Base-line studies will be performed by ADF&G where appropriate, the data being supplied to TES and its consultants

(2) TES and its consultants develop the environmental assessment

(3) ADF&G reviews and comments upon TES work which is reviewed and appropriately modified.

(4) Mitigatory measures are proposed by TES (in some cases relying on data furnished to APA by ADF&G).

(5) ADF&G reviews proposed mitigation plans and offers comments.

(6) TES updates earlier submission

(7) ADF&G approves

This procedure will be followed as necessary throughout the period prior to FERC license approval.

(d) Information Exchange

Our approach to involvement of environmental interests external to the Acres team includes a series of eight workshops, each one of which will be partially or fully devoted to environmental matters. Six of the workshops are scheduled in advance and two are funded but not scheduled to permit flexibility in response to issues of opportunity.

(e) Intepretations of NEPA

We will maintain our close review of recent CEQ actions as well as our monitorship of FERC license processing. We intend as well, through our Alaska Project Office, to maintain continuous close liaison with appropriate State agencies. State agencies will be invited to participate as well in workshop sessions.

(f) Mitigation

The scenario for seeking State approval for mitigation measures has been summarized in subparagraph (c) above. It is our intention to resolve as many of the mitigation issues as possible prior to license application.

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(g) Conflicting or Overlapping Authorities

By seeking the involvement of Federal and State agencies throughout the study period and especially in workshop sessions, we seek to minimize conflicts.

(h) Historic Preservation Concerns

We will schedule necessary consultations on historic preservation matters with appropriate federal and state agencies. Our plans to ensure archeological reconnaissance prior to site disturbance will also contribute to our satisfaction of problems in this area.

(vii) Licensing

Paragraph A.2.1 identified numerous snags which can occur in obtaining an FERC license. Although the list touches upon the problems which appear applicable to Susitna, others can arise during the lengthy process.

Our approach to the licensing issue calls for the establishment of a small team whose entire efforts will be devoted to coordinating the preparation of the total application as well as to maintaining frequent contact with FERC. Whereas individual exhibits will be generally prepared as outputs of other tasks, this focal point for licensing work will provide the means to minimize later interventions by anticipating sensitive issues in advance. Of particular importance will be the impact of new draft regulations when they are published. The early indications are that some cost savings may accrue as a result of simplifications in procedures. Even so, the Plan of Study is necessarily based on satisfaction of current regulations. We will propose changes at a later date if appropriate.

Particularly important in the licensing of a large project such as Susitna is the effective scheduling of preparatory activities. Plate A.2.1 indicates our proposed scheduling of all activities which we propose to undertaken prior to submission of the license application, and afterwards. The essential philosophy of our proposed approach is to involve the FERC as soon as possible and to initiate contacts with all concerned local, state and Federal agencies and individuals well in advance of the submission. Yet the submission must respond adequately to the requirements laid down by the FERC. We confidently project a 30 month period to fully complete the data acquisition requirements for submission of a compliant license application to the FERC. WE base these projections on our experience and discussions with FERC staff. License activities are discussed in detail in Task 10, Section A5 of this POS.

(viii) Public Participation

The overall objectives of the public participation program are twofold: to keep the public fully informed and to provide a means whereby the public can influence the work. These objectives will be satisfied in general by conducting a thorough and enthusiastic public information program which includes multi-media exposure, scheduled events, resources set aside to capitalize on unforeseen information opportunities, and a total commitment to establishment of a continuously available and accessible information office; and the provision for dynamic planning. It is this latter facet of the public participation program which distinguishes it from more conventional approaches. Simply stated, we have built into the study process a provision for incorporating newly identified actions as well as independent review procedures. Our plan of study is an excellent blueprint for licensing. Public input and the sage advice of independent panels of experts cannot help but improve the plan--and thus, the study--as the work proceeds. Our specific approach to resolution of previously identified problems is as follows:

(a) Conflicting Interests

A series of milestones, including all public meetings and workshops, will become the triggers for preparation of action lists. Each substantive comment or concern will be translated into a specific action or will be recommended for rejection by the project manager. Proposed actions with significant impacts on time, schedule, or concept will be referred to APA for specific approval. Other actions of lesser apparent consequences will be routinely processed and undertaken, with APA kept fully informed. Those comments and concerns which are recommended for rejection will be referred for consideration (along with reasons for recommending rejection) to APA and to the appropriate external review board. (Note that both engineering and environmental review boards have been proposed.) The proposed actions as well as recommended rejections will represent the study team's best efforts to resolve conflicting interests and concerns. Even so, there is simple no reasonable way to ensure that all publicly expressed desires will be satisfied. Creation of an action list will provide the vehicle so that every concern is at least explicitly considered and deliberations of external review boards will provide further recourse for those who disagree with the position taken by the project manager.

(b) Impacts on Schedule

The extensive public participation program described in detail in Task 12 (Section A5) and illustrated at plates in that section has been designed to permit maximum public review and comment activities without disrupting the progress of the study. By publishing monthly progress reports, by conducting frequent workshops open to the public, and by allowing ample review periods for important reports prior to public meetings, we believe that it will be possible to maintain the agreed schedule and ensure maximum public participation.

(3) Changing to Accommodate the Public Interest

Whereas it is both possible and proper to plan for review periods under the assumption that the proposed plan of study will proceed as originally prepared, there is simply no way to predict with certainty the extent to which actions introduced through the public participation program will influence schedules and costs. To minimize problems which may occur in this area, we have sought to involve the public immediately upon commencement of the study effort and to establish continuous coordination procedures for various interested agencies, with particular attention to those charged by statute with protection of environmental resources and those to be involved in distribution and sale of electric power. Flexibility has been built into the plan of study to allow for accommodating a reasonable number of changes to be introduced through the public involvement program.

(4) Communications in Alaska

In recognition of the extensive area which would be served by the proposed project, provisions have been made in the public participation program to allow for broad information coverage as well as the widest possible involvement. Each regularly scheduled public meeting is actually a set of three meetings to be held in Anchorage, Fairbanks, and Talkeetna. A total of eight workshops, each one of which may involve separate sessions with utilities, regulatory agencies, and environmental interest organizations, are planned. Locations for workshops will be chosen with a view toward maximizing public exposure. Indeed, the public participation plan is founded on the principle of taking aggressive action to seek public involvement rather than passive tolerance of public interests. No matter when or where meetings are scheduled, though, it is inevitable that some interested individuals will simply be unable to attend. We will have broad information coverage and our proposed information office will receive comments and suggestions at any time during the course of the study. Actions developed as a result of these latter inputs will be treated in a fashion similar to those introduced during or incident to formal meetings and workshops.

(ix) Control and Coordination

A number of approaches to the development of a successful large-project management plan have been tried in the past. We believe, from this experience, that sponsors of large projects are beginning to recognize the importance of first developing a program planning guide for the management of these projects.

The tendency in the past has been to inundate a project with a relatively large number of planners and managers. There is nothing wrong with large numbers of managers and planners, when they are needed, but we believe that the larger and more complex a project, the more important it becomes to have a small group generating the plan. Our experience on large projects has revealed that a relatively small number of planners actually prepare the specifications for the plan. That is, during a preliminary planning phase, they should develop in considerable detail the specific elements that the project manager or construction management contractor or the management organization are to prepare during the planning period. Whether a large project is located in an area that lacks local services and therefore depends upon outside support, or in an area with an existing, well-developed service base, an extensive planning effort is required to handle the great number of parallel and similar organization concepts required to effectively manage the project. We are prepared to include such a planning effort as a product of the POS.

(a) Planning, Control and Management of the POS

Clearly, the POS, with funds in excess of $8 million already allocated and an eventual expenditure of over $20 million, qualifies as a large project and dictates the need for a more than casual approach to the planning and control. A business-oriented approach will be required to deliver, cost effectively, the final products of the POS. Effective "front-end" planning and the early involvement of the project management team is a key determinant of the project's success. Cost/schedule/financial control development and the preparation of corporate/administrative policies and procedures must parallel and be a part of front end planning and design. Effective implementation of the controls and procedures and the participation, acceptance and commitment to follow through to project completion must be incorporated into the program. We are committed to provide these services through the assignment of a relatively small group of well-qualified individuals to the POS team. In particular, the extensive Alaskan experience in large project management offered by FMA will be vital elements in our planning, control and management efforts.

The proposed schedule for undertaking this POS is presented in Plate A2.1.

(b) Planning the Eventual Construction Program

Certainly the multi-billion dollar construction phase of the Susitna hydropower project qualifies as a "giant" project and comes complete with the myriad of problems associated with "giant" projects. In this respect, the ability of the POS team to effectively plan this monumental project may prove to be the most important product of the the POS. The Acres/Moolin team provides a unique combination of talent and concepts to support this planning effort.

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A.2.3 - Proposed Program

The effective resolution of the problems to be dealt with in meeting the overall study objectives require the development of a carefully integrated program of study, design and exploration. The study will be undertaken in a series of interrelated and interdependent tasks as follows:

Task 1 - Power Studies
Task 2 - Surveys and Site Facilities
Task 3 - Hydrology
Task 4 - Seismic Studies
Task 5 - Geotechnical Exploration
Task 6 - Design Development
Task 7 - Environmental Studies
Task 8 - Transmission
Task 9 - Cost Estimates and Schedules
Task 10 - Licensing
Task 11 - Marketing and Finance
Task 12 - Public Participation
Task 13 - Administration

Each of these tasks has been broken down into a manageable number of subtasks (See Section A5). The level of effort and timing allows for progressive determination of project feasibility with minimum expenditure of funds.

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A.2.4 - Potential Difficulties and Anticipated Methods of Handling

Several of the products that are developed as a part of Task 13--Program Administration are going to be the basic documents that will implement the POS. To stress how important they are would be to belabor the obvious; these products establish the basic course for the project and will be used to enunciate strategy and policy desisions throughout the POS. The key to the effectiveness of these programs is the early implementation and acceptance by all members of the project team.

It is extremely important that the interface and responsibilities of each of the subcontractors be spelled out in excruciating detail. This is best done by listing the numerous functions that have to be performed and then making sure that each of these functions have been assigned to a specific team. This sounds simple, but it requires a considerable effort and an in-depth understanding of the scope of work to tabulate all the required functions.

Working with government agencies requires some special precautions. There is a tendency, when submitting plans of operations, to propose exagerated plans or solutions to make them sound as good as possible. These plans must be scrutinized, before submission, for reasonableness and cost effectiveness, to ensure that conditions that cannot later be tolerated are not proposed. It is equally important that the government agencies also participate in the preparation and review of such plans so that constraints may be identified and planned for.

The subject of constraints is of particular importance to the planning and estimating phases of the project. Constraints, if adequately understood in the early stages, can be planned around. Constraints, if they come up after the start of construction, result in breaks in cadence, work stoppages, poor utilization of equipment and manpower and direct impacts to cost and schedule. Constraints can appear in the form of government mandates, environmental/climatic conditions, design changes necessitated by the discovery of new data as construction proceeds and other causes. Regardless of their cause, every effort must be made during the planning stages to identify constraints by working directly with government and other agencies and convincing these agencies to participate in, accept and commit themselves to this effort. In addition, the cost and benefits of constraints must be developed, as the constraints are being identified, to allow APA and government officials to fully assess the impacts involved.

There must also be a close relationship between the planning and the obtaining of permits from government agencies. Included in the Project Planning Guide should be a schedule of submissions that identify what permits are required at what point in time and when each submission will be made. This will go a long way towards easing the acquisition of the myriad of permits required.

The foregoing remarks are necessarily general in nature. Sections A4 through A6 of the POS describe in some detail the potential difficulties foreseen at this time in specific areas of the study and the proposed methods of overcoming them.

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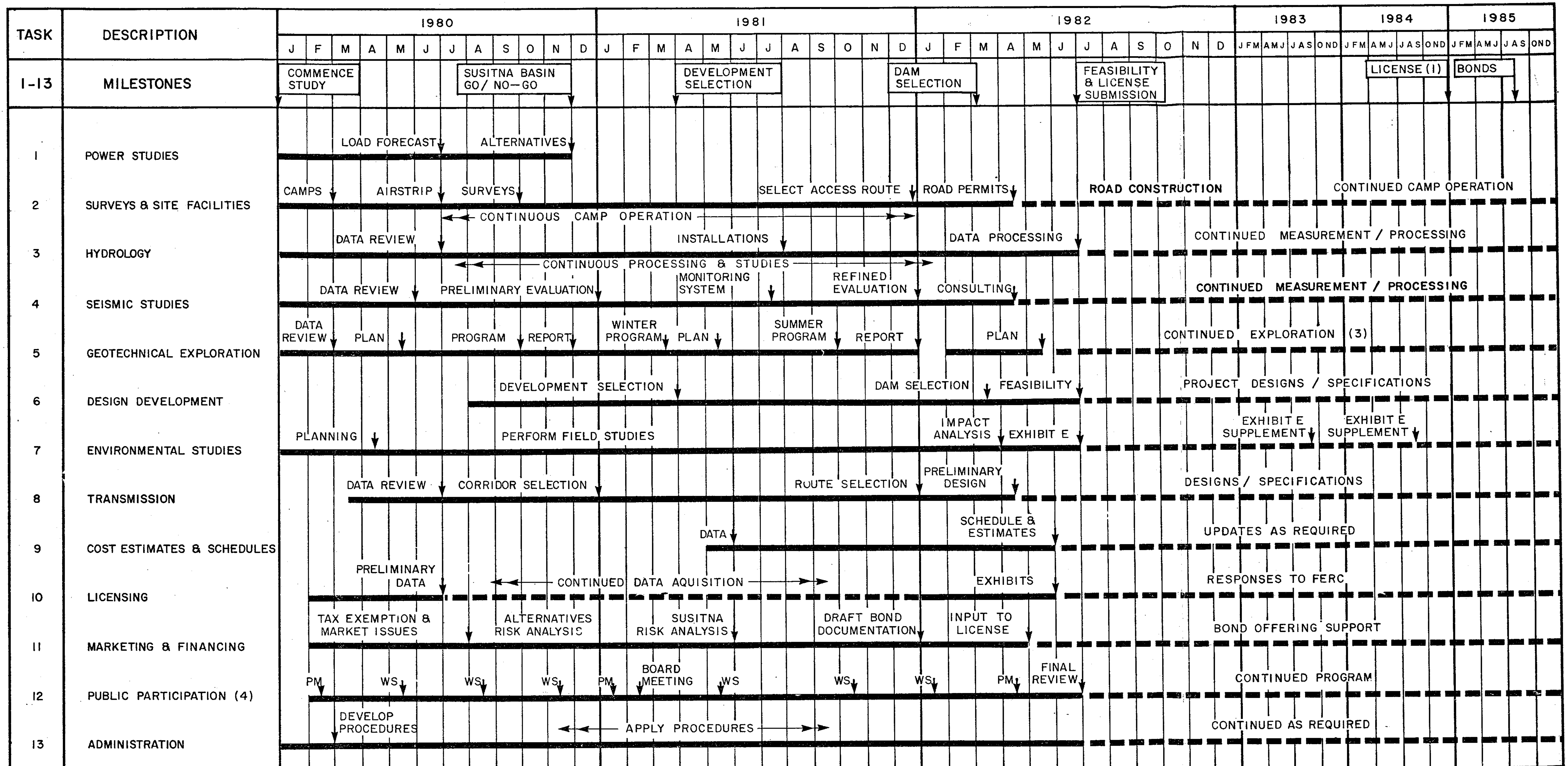

LEGEND: ↓ REPRESENTS SUBTASK COMPLETION

NOTES: (1) TENTATIVE BASED ON COMPLETION OF ENVIRONMENTAL STUDIES AND PLANS FOR INVESTIGATION

(2) ACCESS TRACK CONSTRUCTION IS ASSUMED TO COMMENCE IN 1982 FOR PURPOSES OF "FAST-TRACK" PROJECT COMPLETION ONLY. COSTS ARE INCLUDED IN ACTIVITIES UNDERTAKEN AFTER SUBMISSION OF LICENSE APPLICATION.

(3) GEOTECHNICAL EXPLORATION IS ASSUMED TO CONTINUE THROUGH 1988 FOR PURPOSES OF "FAST-TRACK" COMPLETION. COSTS ARE INCLUDED IN ACTIVITIES UNDERTAKEN AFTER SUBMISSION OF LICENSE APPLICATION.

(4) PM = PUBLIC MEETING ; WS = WORKSHOP

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SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE A2.1: SUMMARY SCHEDULE

A3: BUDGET SUMMARY

SECTION A.3 - BUDGET SUMMARY

Summaries of estimated study costs for periods through submission of the FERC license application (June 30, 1982) and subsequently through receipt of license (tentatively estimated as January 1985) are presented in Tables A.3.1 through A.3.3. These summaries are presented by Task and quarter. All costs are in 1979 dollars, effective through the first quarter of 1980, with escalation beyond that date assumed at a rate of 8 percent per annum.

Subtotals for Tasks 1 through 10 are separated out since these are considered to correspond most closely with the estimates presented in the Corps of Engineers POS. Additional expenditures for the proposed project financing activities (Task 11) and public participation program (Task 12) are substantially different in concept from anything included in the Corps POS. The estimated costs of these activities have therefore been shown as separate items. Task 13, Administration, may also be regarded as essentially an indirect cost to the project for the Acres team office in Alaska. This is also shown separately together with other costs stipulated by APA as shown.

It must be emphasized that costs incurred after submission of the license application are based on design development of the Watana site only in this period, and are necessarily approximate at this time. The level of engineering to be performed prior to award of the license will depend largely on the optimum method of contract packaging selected during feasibility studies, the scheduling of the construction contracts and the problems identified during the feasibility study. Nevertheless, the costs are representative of a scenario which in our judgement will result in accomplishing the objectives of the study (i.e., to license, finance and commence the construction of the project at the earliest feasible date) at minimum risk to the State of Alaska.

TABLE A.3.1 - BUDGET SUMMARY - PRE-LICENSE APPLICATION STUDIES (1979)
January 1, 1980 to June 30, 1982

Task No.	Task Name	Acres American Head Office	Acres American Alaska	R&M Consul-tants Alaska	Woodward - Clyde Consultants Head Office	Woodward - Clyde Consultants Alaska	Terrestrial Environmental Services Head Office	Terrestrial Environmental Services Alaska	FMA Alaska	CIRI H&N Alaska	ADF&G Alaska	External Consultants Other	External Consultants Alaska	External Review Panel	Task Totals	Cumulative Totals
1	Power Studies	57,000	15,000	--	--	280,000	27,500	27,500	--	--	--	--	--	--	407,000	
2	Surveys & Site Facilities	63,000	47,500	1,005,900	--	--	--	--	510,000	3,353,400 (1)	--	--	--	--	4,979,800	--
3	Hydrology	193,200	20,000	1,354,900	--	--	--	--	--	--	--	--	17,500	--	1,585,600	--
4	Seismic Studies	40,000	18,000	--	761,000	320,000	--	--	--	--	--	--	--	35,000	1,174,000	--
5	Geotechnical Exploration	257,000	665,000	2,698,500	--	--	--	--	--	--	--	--	--	--	3,620,500	--
6	Design Development	1,599,000	165,000	5,000	--	--	--	--	--	--	--	--	--	80,000	1,849,000	--
7	Environmental Studies	58,900	45,000	--	--	--	354,700	380,900	--	--	1,855,900	120,000	2,045,700	--	4,861,100	--
8	Transmission	684,300	25,000	--	--	--	--	--	--	--	--	20,000	--	--	729,300	--
9	Construction Cost Estimate & Schedule	66,000	65,000	--	--	--	--	--	54,000	--	--	--	--	--	185,000	--
10	Licensing	226,500	57,000	--	--	--	--	--	--	--	--	--	10,000	50,000	343,500	--
	Subtotals	3,244,900	1,122,500	5,064,300	761,000	600,000	382,200	408,400	564,000	3,353,400	1,855,900	140,000	2,073,200	165,000	19,734,800	
11	Marketing & Financing	629,600	157,400	--	--	2,500	--	--	5,500	--	--	--	--	--	795,000	--
12	Public Participation	133,300	443,300	18,500	8,500	10,000	8,500	10,000	12,800	12,800	--	--	--	--	657,700	--
13	Administration	24,400	120,000	--	--	--	--	--	157,000	--	--	--	--	--	301,400	--
	Subtotals	787,300	720,700	18,500	8,500	12,500	8,500	10,000	175,300	12,800	--	--	--	---	1,754,100	21,488,900

Non-discretionary amounts:

Private Land Use Payments ($36,000 per year)	90,000	
Full Time Native Inspector ($3,000 per month)	90,000	
APA Study Coordination and Review	250,000	
Independent Cost Estimate and Seismic Risk Analysis	1,000,000	
ADF&G Environmental Coordinator ($75,000 per year)	187,500	
	1,617,500	23,106,400

(1) A total of $1,443,500 has been assumed as the salvage value of camps to be transferred for use during continuing field investigations after license application is filed.

TABLE A.3.2 - BUDGET SUMMARY - POST LICENSE APPLICATION STUDIES
($ 1979)

Task No.	Task Name			Cumulative Totals
1	Power Studies	--		
2	Surveys & Site Facilities	4,600,000 (1)		
3	Hydrology	1,380,000		
4	Seismic Studies	750,000		
5	Geotechnical Exploration	2,500,000		
6	Design Development	1,900,000		
7	Environmental Studies	4,940,000 (2)		
8	Transmission	--		
9	Construction Cost Estimate and Schedule	200,000		
10	Licensing	430,000		
	SUBTOTAL		16,700,000	
11	Marketing & Financing	450,000		
12	Public Participation	250,000		
13	Administration	200,000		
	SUBTOTAL		900,000	17,600,000
Non-discretionary Amounts				
	Private Land Use Payment	90,000		
	Full Time Native Inspector	90,000		
	APA Coordination & Review	250,000		
	ADF&G Environmental Coordination	187,500		
	SUBTOTAL		617,500	18,217,500
Pioneer Access Road Construction			8,000,000	26,217,500

NOTE: (1) Excluding Demobilization
(2) Including ADF&G Costs

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TABLE A.3.3 - ESTIMATED STUDY COSTS BY QUARTER
PRE-LICENSE APLICATION STUDIES ($ 1000)
January 1, 1980 to June 30, 1982

Task No.	Task Name	Quarters 1980 1	1980 2	1980 3	1980 4	1981 1	1981 2	1981 3	1981 4	1982 1	1982 2	Totals
1	Power Studies	67.0	102.0	171.0	67.0	--	--	--	--	--	--	407.0
2	Surveys & Site Facilities	746.8	715.0	606.0	472.0	429.0	429.0	428.0	402.0	376.0	376.0	4,979.8
3	Hydrology	9.6	141.0	151.0	176.0	186.0	186.0	186.0	186.0	186.0	178.0	1,585.6
4	Seismic Studies	61.0	203.0	260.0	207.0	28.0	113.0	157.0	111.0	19.0	15.0	1,174.0
5	Geotechnical Exploration	45.0	408.0	806.0	90.5	567.0	798.0	771.0	47.0	59.0	29.0	3,620.5
6	Design Development	--	--	82.0	83.0	104.0	151.0	296.0	516.0	513.0	104.0	1,849.0
7	Environmental Studies	552.0	552.0	552.0	552.0	555.0	554.0	554.0	522.1	279.0	189.0	4,861.1
8	Transmission	4.0	37.7	49.0	50.6	44.0	109.0	129.0	135.0	135.0	36.0	729.3
9	Construction Cost Estimate & Schedule	--	--	--	--	--	47.0	13.0	13.0	44.0	68.0	185.0
10	Licensing	63.5	30.0	15.0	15.0	15.0	15.0	15.0	21.0	23.0	131.0	343.5
11	Marketing & Financing	126.0	126.0	48.0	36.0	49.0	47.0	36.0	51.0	85.0	191.0	795.0
12	Public Participation	379.0	26.7	27.0	27.0	58.0	27.0	26.0	14.0	28.0	45.0	657.7
13	Administration	104.8	22.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	13.6	301.4
	SUBTOTALS ($ 1979)	2,158.7	2,363.4	2,790.0	1,799.1	2,058.0	2,499.0	2,634.0	2,041.1	1,770.0	1,375.6	21,488.9
	Provision for Escalation (based on 8% per year)	0.0	47.0	111.0	108.0	167.0	255.0	324.0	296.0	297.0	263.0	
	SUBTOTALS ($ escalated)	2,158.0	2,410.4	2,801.0	1,907.1	2,225.0	2,754.0	2,958.0	2,337.1	2,067.0	1,638.6	23,256.2
Non-discretionary amounts												
	Private Land Use	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	90.0
	Full Time Native Inspector	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	90.0
	APA Study Coordination and Review	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	250.0
	ADF&G Environmental Coordinator	18.7	18.8	18.7	18.8	18.7	18.8	18.7	18.8	18.7	18.8	187.5
	SUBTOTALS	61.7	61.8	61.7	61.8	61.7	61.8	61.7	61.8	61.7	61.8	617.5
	TOTALS	2,219.7	2,472.2	2,862.7	1,968.9	2,286.7	2,815.8	3,019.7	2,398.9	2,128.7	1,700.4	23,873.7
	Independent Cost Estimate and Seismic Risk Analysis											1,000.0
	GRAND TOTAL											24,873.7

A4: LOGISTICAL PLAN

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SECTION A4 - LOGISTICAL PLAN

(a) Statement of Problems

The sheer magnitude of the proposed project is itself virtually a guarantor of problems scaled to match. This plan seeks to anticipate and address major problems in advance--and thus to reduce the force of their impacts. Problems to be considered include:

(1) Land Use Restrictions and Permit Requirements. The unique nature of the proposed project area is such that land use restrictions and permit requirements will be imposed by multitudinous agencies. This subject is developed in further detail in subparagraph (b) below.

(2) Access. Perhaps the single greatest physical constraint on rapid successful completion of necessary site investigations is the difficulty of access. The project area is far from existing roads and no airfield is available to serve Watana dam site. The bulk of the project supplies (including fuel needs) must be brought overland during the winter months, demanding careful, detailed, expert advanced planning for a full year's operation. Even helicopter access is difficult (in addition to being expensive) since weather conditions including fog, winds, freezing rains, icing conditions, and snow frequently restrict or prevent helicopter use.

(3) Seasonal and Cyclical Constraints. The nature of the required work is such that a number of peak manning loads will occur, particularly during short summer seasons. The relative brevity of important data collection periods and the extensive time lapse before like collection activity can occur make it imperative that the proper investigators be at the correct location with the necessary equipment on time. (In this regard, for example, abortive data collection efforts during a particular spawning season may not be recouped for five years.)

(4) Weather. The effect of adverse weather on helicopter operations has already been noted above. Beyond the access question, though, is the extent to which weather conditions impact project operations. Consider aerial photography requirements, for example. The period after snow melt and prior to leaf cover is important, but weather conditions may severely limit its already short duration. Project planning must allow for weather delays as well as for gainful production on alternative tasks during inclement weather.

(5) Coordination of Subcontractor Activities. Acres has assembled a strong team representing high qualifications in a number of project areas as well as a substantial Alaskan presence. The strength of such a team can only be brought to bear fully and well if a proper system for management and coordination of diverse

activities is employed. This is especially true in view of the widespread geographical dispersion of various design offices.

(b) Summary of Land Use Restrictions and Permit Requirements

(1) Interested Agencies. A number of organizations and agencies have direct interests in the project area. These include:

- Bureau of Land Management under whose control all lands now fall.

- Native villages which have already made selections, generally along the Susitna River, bordering federal power reserves which had been established prior to Alaska's assumption of Statehood. It should be noted that the power reserve does not include all of the land which would be required for the Watana reservoir as proposed in the Corps of Engineers' pre-authorization study (resulting, of course, from the Corps' selection of a higher dam at Watana than had earlier been proposed in studies by the Bureau of Reclamation). Native villages ultimately acquire surface rights to virtually all of the lands bordering proposed reservoirs as well as certain downstream and general vicinity parcels.

- Cook Inlet Region Incorporated, which will acquire all subsurface rights to the Native Village lands and which may temporarily receive and hold lands in trust until they are ultimately conveyed to individual villages in accordance with prior selections.

- Alaska Department of Natural Resources, which administers water rights. The State is the owner of all lands lying under the Susitna River and its tributaries.

- The Alaska Department of Fish and Game, whose responsibilities for protection and management of wildlife resources are essentially independent of ownership.

- The U.S. Army Corps of Engineers who are charged by Congress with administering permit programs for navigable waters and for wetlands.

- Other federal agencies whose involvement is assured because a federal license is required. (Thus, it is not necessarily true that the passage of land ownership to Native Corporations will eliminate most federal permit requirements or interventions. In this regard, for example, federally legislated archeological checks and clearances are expected to be required even though land ownership may have been transferred from the federal domain.) Particular agencies involved in coordination and/or permitting include the Fish and Wildlife Service, National Marine Fisheries Service, and the Environmental Protection Agency.

- Other State agencies whose concerns include water and air quality--and others which will control certain lands in the Susitna Basin which may ultimately be acquired by the State in exchange for lands selected elsewhere by Natives.

(2) Constraints. The net effects of dealing with diverse permitting agencies and resolving uncertainties in land ownership or water rights will be multifold. Surely they demand careful and detailed advanced planning, backed by experience in Alaska, for it matters little that 15 necessary permits have been acquired when one forgotten one holds up any work on a project. They also demand carefully coordinated application and implementation procedures, for care must be taken to ensure that funds are not twice expended to comply with a single provision common to two permits.

We intend to produce a high quality, technically correct, economically sound, environmentally acceptable report--including FERC license application if alternatives analysis and other studies support it--on time and without introducing permanent damages in the project area. It is this latter damage avoidance objective on which most permits are based. It follows that permittee and permittor should, in every case, be able to resolve apparent difficulties and proceed with the necessary activities.

(c) Proposed Methods for Dealing With Problems

The very fact that land use is severely restricted suggests that the closest possible relationship should be established with the land owners. Because we anticipate seeing ownership pass to the Cook Inlet Region, Inc., (CIRI), and thence ultimately to various selecting Native Villages, we propose to engage CIRI (in association with its engineer, Holmes and Narver (H&N)) to undertake a major share of the logistics activities in support of the project. Our own management system will be such that a responsible senior Acres official with decision-making authority will establish a project office in Anchorage, from which all in-state activities will be coordinated. The Project Manager will divide his time between in-state field data collection and out-of-state activities to include sophisticated design efforts in the home offices, seismic analysis at WCC offices in California, coordination with federal agencies (including FERC) as appropriate, and similar tasks. In later stages of detailed design, he will also need to review hydraulic model tests in Niagara Falls, ice studies at the Cold Regions Laboratory in New Hampshire (provided government projects do not preempt), and confer with potential manufacturers and suppliers.

Certain specific points may be made regarding the proposed logistical operation:

(1) CIRI/H&N will provide the layout and design of a semipermanent camp near Watana and a tent camp for establishment near Devil Canyon, if required.

(2) CIRI/H&N will furnish all camp equipment, furniture, materials

and supplies except for fuel and pad for each camp. R&M will provide the pad.

(3) CIRI/H&N will furnish transportation of all building materials for both camps to Watana. The movement of camp materials to Devil Canyon will be provided by helicopters to be chartered by Acres.

(4) CIRI/H&N will operate and maintain both camps and furnish all food and camp operating supplies except fuel. FMA will supply air transportation for personnel and summer resupply of food and consumables.

(5) CIRI/H&N will obtain the permits required for both camps.

(6) CIRI/H&N will operate the camps on the following schedule:

- Watana: Year round, February 1980-June 1982

- Devil Canyon: June through September 1980 and June through September 1981

(7) The Watana Camp will house a maximum of 60 persons (including O&M staff). The Devil Canyon camp will house 20 persons (including O&M staff).

(8) CIRI/H&N will furnish electrical power, water and sewage systems for each camp. A small, biological sewage treatment plant will be installed to handle the camp sewage wastes. Incineration and/or approved burial methods will be used to dispose of other camp wastes. All operations will be conducted in accordance with DOI stipulations and DEC permits and regulations.

Local surface water sources will be investigated and economic studies performed to determine the suitability of supplying the camp water needs. If local surface water proves unsuitable, then installation of a well will be required.

(9) CIRI/H&N will furnish communications equipment:

- Ground to aircraft: appropriate navigational aids and communication facilities will be installed in support of air operations.

- Camp to work site: A base station shortwave radio will be installed at each camp location, and mobile radios will be carried by each work crew in the field. In addition, mobile radios will be installed in helicopters to allow communication with the camp and ground crews.

- Camp to outside: It is expected that the communication needs of the POS will require the installation of telephone lines to the camp facilities. Typically, these requirements have been grossly underestimated. We will work closely with local communication subcontractors to establish the level of hardware required to support the project.

(10) The Watana Camp, as furnished by CIRI/H&N, will consist of the following facilities::

- Dormitories of 64 persons (2 persons/room), toilet, showers, and personal laundry facilities (washer/dryer).

- Kitchen/diner with food storage

- Offices: 4 each (200 sq. ft.,total 800 sq. ft.) with furniture, but without office machines, i.e., typewriters, adding machines or photocopiers, etc.

- Recreation hall with: pool table, ping pong table, TV/Video tape player, movies.

  CIRI/H&N will supply movies and video tapes.

- Fuel storage: fuel storage dumps will be installed to provide adequate storage of diesel and jet (helicopter) fuels. Bladder tanks installed in approved, lined and diked areas will service the needs of the camp and aircraft:

  Jet fuel - 3 each, 25,000 gallon bladder tanks
  Gasoline - 1 each, 25,000 gallon bladder tanks
  Diesel fuel - 6 each, 25,000 gallon bladder tanks
  Propane - 2 each, 500 gallon tanks

- Laundry facilities for sheets, towels and kitchen linen

- Warehouse/shop, not including shop equipment

- Generators and generator shelter

- Water system with storage

- Sewage/incinerator system

- Dormitories, kitchen/diner, and recreation facilities to be connected via Arctic walkways.

(11) The Devil Canyon camp (if required--see item 23) as furnished by CIRI/H&N will consist of the following facilities:

- 10 each, 2-man tents with wooden floors
- A kitchen/diner tent with wooden floors
- Food storage
- Shower facilities
- Incinerator toilets
- Fuel storage
- Generator and generator shelter
- Water system.

(12) Food services will include well-balanced meals (three times per day - typically):

Hot breakfast: 6 a.m. to 7 a.m.
Cold sack lunch
Hot dinner: 6 p.m. to 7 p.m.
Pastries, fruit and coffee for snacks

(13) The following items are to be supplied as noted:

- All fuel required, estimated as follows for camp operations (Acres):

*Diesel	1980	1981	1982
	110,000 gal	120,000 gal	60,000 gal

Note: diesel fuel required for power plant, water pumping and incineration of sewage/garbage.

- Office equipment and supplies (Acres)

- Air transportation (including emergency) for personnel (FMA)

  All personnel will move to and from the field camp by light aircraft originating at the Talkeetna airfield. Overland transportation will be provided to Talkeetna from other locations. Transportation from the field camp to specific work sites will be provided by helicopter support. Where possible, field personnel will travel to work sites on foot.

- Air transportation of food and consumable supplies from Anchorage as required (FMA). It is estimated that the weekly requirement will be as follows:

  Summer - 4,000/lbs/week (average)
  Winter - 2,000/lbs/week (average)

(14) The timely mobilization of the Susitna Camp in February 1980 is contingent upon having lead time to procure (90 - 120 days) camp buildings, generators, sewage treatment plant, pillow tanks, etc.

(15) CIRI/H&N will apply for and secure all permits necessary for any aspect of camp establishment and operation.

(16) CIRI/H&N will provide the single coordinating point for satisfaction of Alaskan Native Corporation land use stipulations.

(17) Acres American Incorporated will establish a project office in Anchorage and will designate a senior staff member with decision authority as Chief Engineer for Alaska operations (CEAO). The project office will accommodate representatives of other team members as well.

(18) All plans of operations as required by Bureau of Land Management will be prepared under the direction of the Acres CEAO. Specific responsibilities for preparation of plans within the proposed project team include:

- Overland transportation - CIRI/H&N
- Foundation and materials explorations - R&M
- Fuel transportation and storage - CIRI/H&N
- Fire prevention and suppression - CIRI/H&N
- Wetlands survey - TES
- Biological studies - TES
- Waste disposal - CIRI/H&N
- Air operations - FMA
- Surface resource rehabilitation - R&M
- Personnel housing and transportation - CIRI/H&N

(19) The CEAO will prepare a detailed affirmative action plan for APA approval in which precise measures are set out to ensure maximum opportunities are made available to minorities, females, and handicapped persons. (We have already sought the assistance of CIRI/H&N to serve in the role of labor broker to ensure that, when available, necessary skills are drawn from the Native population in villages which have selected project lands.)

(20) If it can be shown to be cost effective, a tie line connecting the corporate headquarters of Acres American with the CEAO's office will be established to permit frequent uninhibited contact. In addition, Telex facilities in the Alaska project office will be installed so that time zone difficulties will not preclude receipt of messages transmitted at times when one or another of the various Acres' offices on the net is unmanned.

(21) A trained value engineering officer, drawn from within the Acres' staff, will review major operational plans and project designs throughout the course of the work.

(22) To the extent that necessary goods and services are available in Alaska, they will generally be procured in Alaska (unless significant economic advantages to APA can otherwise be secured).

(23) Plans for the Devil Canyon tent camp will be eliminated if use of the Devil Canyon Lodge is shown to be cost effective.

(24) To permit the earliest possible start of field activities, initial minimal winter camp facilities will be established in the same location as used by the Corps of Engineers in their recent drilling program. No expansion beyond the bounds of that area will be possible until snow cover disappears and appropriate archeological clearances are obtained.

(25) During the initial winter months, an accessible frozen lake will be cleared to allow access to the study site by Hercules Aircraft. As soon as conditions permit, construction of a 5,000 ft gravel airstrip will commence. The airstrip will be located in a manner that will service the temporary construction camp and also allow for possible expansion of facilities to serve the eventual dam construction.

(26) Fire is the most ever-present danger to a camp and its occupants in Alaska. The most common cause of camp fires are uncontrolled incinerators and leaking seals on individual oil fired furnace units. Because of the risk involved, positive actions will be taken including:

- Installation and periodic inspection of smoke alarms
- Periodic inspection of furnaces
- Installation of fire fighting equipment
- Establishment of a fire brigade.

(27) Safety/OSHA/Fire Prevention - Periodic inspections of all site facilities will be peformed by trained personnel to evaluate and make recommendations regarding safety, compliance with OSHA standards and fire prevention programs. A safety officer will be designated. This person will organize camp fire brigades and report on the effectiveness of the effort. He/she will report directly to the project manager of field activities and will have the authority to stop work that is being performed in an unsafe manner.

(28) Medical - At a minimum, each field camp will have complete first aid facilities and personnel identified with advanced first aid training. Qualified personnel will review the first aid program and make recommendations as appropriate. Medevac facilities and procedures will be available in the event injured personnel need to be transported to other facilities.

(29) Office Services - Office services (typing, reproduction, etc.) appropriate to each field location will be provided as needed. Complete facilities will be available through Moolin and R&M offices in both Anchorage and Fairbanks, as well as the project office to be established in Anchorage by Acres.

(30) Purchasing - A purchasing office within the project office, staffed by an experienced procurement person(s), will be established in Anchorage to support the needs of the POS. In addition, a purchasing/warehouse person will be located in the field camp to coordinate the procurement needs, operate the camp warehouse and administer a spare parts program.

(31) Shipping/Marshalling - Procurement personnel located in Anchorage will coordinate the movement of all project materials from vendors to the camp location(s). Most materials will travel overland to a marshalling yard to be established in Talkeetna where materials will then be air shipped to the field site. Perishable items and "hot" items will be air shipped direct from Anchorage to the field locations. Materials that cannot be air shipped will be transported overland during winter in accordance with DOI stipulations.

(32) Warehousing - An appropriate warehouse will be established at the field construction camp to store/control the material needs of the POS. Minimal indoor storage will be provided, with the bulk of the material being stored outdoors. A procurement/warehouse person will be responsible for the flow and control of all materials.

(33) Equipment Support/Spare Parts - Based upon previous experience with equipment use in Alaska, particularly during winter/arctic conditions, the establishment of a spare parts program is a necessity to ensure equipment availability and cost effective completion of the POS. Such a program will be developed, with the help of the local equipment vendors, and administered through the procurement/warehouse person.

It is important to note that camp facilities will be designed to accommodate a much greater peak load than had originally been contemplated in the earlier Corps of Engineers' Plan of Study. This approach will permit some flexibility in meeting the difficulties associated with short data collection seasons and possible unfavorable weather conditions. In addition, our plan to establish a large camp at Watana essentially eliminates the daily helicopter transportation system used by the Corps of Engineers during their most recent field investigations. The question of needed flexibility is further addressed by observing that the necessary equipment for field investigations and, in partciular, for geotechnical investigations is integral to the proposed project team. Because R&M Consultants, Inc., is unique in its possession of a major investigatory equipment inventory, we anticipate being able to respond rapidly when requirements arise--and, at the same time, to avoid the costly downtime which would accrue for equipment brought into Alaska specifically for the project purpose.

In short, R&M's equipment will be available for project purposes as necessary; but its use on other tasks when not required for the Susitna project will reduce the total cost to the Alaska Power Authority.

(d) Schedule Requirements

A brief outline logic diagram is displayed at Plate A.4.1. As may be noted thereon, we intend to have a permanent camp in operation prior to the end of February 1980. This requires herculean effort and high early mobilization costs. Once the camp has been established, the subsequent loading will, of course, be a function of requirements of the various field investigation teams.

We anticipate at the outset that submittal of license application will not mark the end of field data needs. On the contrary, certain environmental field studies will be scheduled as far as 2-1/2 years beyond the planned FERC application. In addition, the history of major hydroelectric licensing effort is replete with post-application federal demands for additional field data. It follows that the permanent camp should remain in place at the termination of the first phase of the work to support scheduled and directed activities. Thus, the cost estimate for camps as contained in the appropriate work package assumes amortization of the facilities over a 5-year period, permitting a substantial salvage value to be transferred to the next phase and to be used as an offset against otherwise high costs to be incurred prior to license application.

(e) Public Participation Philosophy

Details of the proposed public participation program are contained within the detailed task descriptions at Task 12 of the Plan of Study. Within the context of logistical planning, however, it is important to highlight several points:

(1) Needs and Desires of Area Residents. Whereas it is obvious that, if a major project is constructed, permanent impacts will be felt by area residents, it is also true that even the conduct of a deliberate and extensive study can cause disruption of lifestyle for that group. The public participation plan includes provisions for public meetings in Talkeetna (where local impacts are possible) as well as a number of workshops, the locations of which have been purposely not pinned down in order to permit us to be responsive to sensitive problems when - and especially where - they arise. We have also chosen to include a full time public information officer whose duties demand sensitivity to needs and desires of all who will be affected either by the study or by the proposed project if studies indicate it should be built.

(2) The Action List. The unique action list system which we propose to use will provide a means to ensure that every required action, whether initiated by the request of a private individual or any representative of public or private organizations, is a matter of record. The proposed computerized system provides for frequent update and the ability to check action status at any time. It follows that, for the first time to our knowledge, a means will be available to ensure that every action requested will have explicit attention and a by-name action officer - or will have an explicit statement of rejection available for review by external review panels, APA, or others. In short, the desires of area residents will be sought, recorded, acted upon, and the action status will be available in real time all the time!

(3) Getting Out the Information. With a project as large and complex as the one proposed, it is almost inevitable that a steady flow of highly technical data and reports will be generated. Whereas such information will generally be available to the public at the cost of reproduction, it will not have been prepared for the layman. We intend to prepare special brochures, to be distributed free of charge, wherein project status is encapsulated in a readable form. Pertinent reports of all kinds will be available sufficiently far in advance of public meetings to permit thoughtful study prior to presenting public testimony.

(4) Keeping Objectivity. No matter how well intentioned the project manager and his staff may be, they may well succumb to their own enthusiasm. We propose to avail ourselves of the objectivity which can be brought to bear by external engineering and environmental boards whose reviews from time to time will not only provide the public a measure of confidence that the course of the work is correct and proper, but also will serve to offer some recourse in the event that the project manager's recommendation and APA's decision to reject a citizen's proposed action is not accepted.

In short, the public participation program as proposed herein is responsive to the needs and desires of local residents - and to the public in general - because it provides explicit actions which can be tracked, because it includes an affirmative and vigorous public information program, and because it provides objective review groups whose eminence will be unquestionable and whose deliberations will provide an unprecedented quality and reliabilty check.

A5: DETAILED ACTIVITY DESCRIPTIONS

TASK 1: POWER STUDIES
TASK 2: SURVEYS AND SITE FACILITIES
TASK 3: HYDROLOGY
TASK 4: SEISMIC STUDIES
TASK 5: GEOTECHNICAL EXPLORATION
TASK 6: DESIGN DEVELOPMENT
TASK 7: ENVIRONMENTAL STUDIES
TASK 8: TRANSMISSION
TASK 9: COST ESTIMATES AND SCHEDULES
TASK 10: LICENSING
TASK 11: MARKETING AND FINANCE
TASK 12: PUBLIC PARTICIPATION
TASK 13: ADMINISTRATION

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SECTION A5 - DETAILED ACTIVITY DESCRIPTIONS

A.5.1 - Introduction

As discussed in Section A2 it is proposed to achieve the objectives of the Susitna Plan of Study by undertaking a program of work divided into the following 13 tasks:

Task 1 - Power Studies
Task 2 - Surveys and Site Facilities
Task 3 - Hydrology
Task 4 - Seismic Studies
Task 5 - Geotechnical Exploration
Task 6 - Design Development
Task 7 - Environmental Studies
Task 8 - Transmission
Task 9 - Construction Cost Estimates and Schedules
Task 10 - Licensing
Task 11 - Marketing and Financing
Task 12 - Public Participation
Task 13 - Administration

Within each of these tasks, a series of subtasks has been identified as shown on the Master Schedules, Plates A7.1 and A7.2. Plate A2.1 is an overall summary schedule for the entire Plan of Study. More detailed schedules and logic diagrams for some specific areas of the study appear under individual subtask description in this section of the POS. In the following subsections the Scope Statements for Tasks and Subtasks are presented and discussed. A complete listing of all subtasks with associated costs is presented in Section A3 - Budget Summaries.

Throughout this section of the proposal, reference will be found to "Design Transmittals". This term is used by Acres to describe a formalized document prepared to present the engineers or designers response in definitive terms as to how he interprets a statement of work and how he intends to proceed with the detailed engineering. The "Level of Effort" shown for each subtask relates to the completion of that task as part of the combined effort of all participants.

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TASK 1: POWER STUDIES

A.5.2 - TASK 1: POWER STUDIES

(i) Task Objectives

To determine the need for power in the Alaska Railbelt Region, to develop forecasts for electric load growth in the area, to consider viable alternatives for meeting such load growth, to develop and rank a series of feasible, optimum expansion scenarios and finally to determine the environmental impacts of the selected optimum scenarios.

(ii) Task Output

The primary output of Task 1 will be a report dealing with the selection and ranking of optimum system expansion scenarios for the Alaska Railbelt Region. The final version of this report will be submitted for review and approval by Alaska Power Authority on or about Week 48 of the Study. Preliminary findings of the study will be discussed with Alaska Power Authority on or about Week 30 of the Study. Such a discussion will center on whether or not work on the Susitna Development should continue or whether another, possibly more viable alternative should be examined. Design Transmittals outlining intermediate stages of the power studies will also be issued as indicated on the logic diagram, Plate T1.1

(iii) List of Subtasks

Subtask 1.01 - Load Forecasting Methodology
Subtask 1.02 - Development of Load Growth Scenarios
Subtask 1.03 - Selection of Alternatives
Subtask 1.04 - Selection of Viable Expansion Sequences
Subtask 1.05 - Expansion Sequence Impact Assessments
Subtask 1.06 - Power Alternatives Study Report

(iv) Subtask Scope Statements

The primary purpose of Task 1 as discussed in Section (ii) above is the establishment and documentation of appropriate load forecasts for the Alaska Railbelt area and the development of optimum system expansion sequence scenarios to meet this forecast. The evaluation of these factors for the Railbelt Region and the relationship and scheduling of Task 1 to the remaining twelve tasks of the overall Plan of Study are illustrated in the master schedule, Plate A7.1. This portion of the study will be undertaken in essentially three parts. The initial phase will deal with the development of appropriate load forecast scenarios of low, medium and high peak loads. The second portion of Task 1 will deal with the development of optimum mixes and sequences of feasible alternative sources for meeting future power demands. These mixes will be developed with and without the Susitna Project, which at this stage will be assumed for study purposes to be that developed by the Corps of Engineers. The third section of the study will deal with the preliminary, comparative environmental and socioeconomic impacts of the developed optimum mixes on the Railbelt Region.

In order to meet the overall objectives of the Plan of Study as stated in Section A2 above, other activities of the program will proceed in parallel with Task 1. These will essentially involve Task 2 - Surveys and Site Facilities, Task 3 - Hydrology, Task 4 - Seismic Studies and Task 5 - Geotechnical Exploration. For logistical reasons, these activities will have been initiated on the assumption that the Susitna Project will be that which proves to be the optimum development for Alaska Power Authority. However, the Task 1 power studies may determine otherwise. Under such circumstances, the ongoing studies would be halted pending discussions with Alaska Power Authority to determine the future course of action most appropriate. On the other hand, should Task 1 studies confirm the earlier studies undertaken by the Corps of Engineers and others that the Susitna Project, with dams at Watana and Devil Canyon as the appropriate means of meeting future load growth in the Railbelt area, the study will continue as planned.

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Subtask 1.01 - Load Forecasting Methodology

(a) Objective

Evaluate alternative forecasting methodologies in the context of the characteristics of the Alaska Railbelt Region, data requirements and availability, and select an appropriate method for load forecasting.

(b) Approach

Forecasting models can be divided into those based upon exponential growth models, those that employ multiple linear regression models and those which derive electrical demand as a result of multiplying estimates of customer usage by the number of customers.

An additional distinction can be made among the forecasting models according to whether the ultimate forecast is the result of a single component model in which annual peak demand is forecast directly, or a two-component model in which a base demand and a weather-sensitive demand are forecast separately and combined to determine the peak. A single component or a two-component model may be used by a utility employing a model in any of three categories listed above.

Much use will be made of econometric modelling work already undertaken in Alaska by the Institute of Social and Economic Research under the direction of Assistant Professors T.L. Husky and O.S. Goldsmith. Consideration will be given to using the Institute's econometric model or a modification of it in order to arrive at the most effective load forecasting tool.

(c) Discussion

The exponential growth models, despite fitting historical data extremely well, are not suitable for predicting the post 1973 growth. We will concentrate on examining several multiple regression models and derived demand models. Some of the candidate models include CILCO's derived-demand model, California's Energy Resources Conservation and Development Commission (ERCDC) model, and a current two-stage econometric model.

In evaluating the regression models, the three steps in their usage, namely model design, estimating the regression equations, and forecasting will be examined. Model design involves the selection of the independent variables and the formulation of the mathematical relationship between variables. The explanatory (independent) variables will be examined for their economic relevance.

Estimating the regression equation involves use of historical data. Limitations in these data may preclude the inclusion of variables even though they are relevant. Availability of data, as well as the regression model statistical validity will be examined.

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The final step in using regression models involves the application of the estimated equation to forecasts for the explanatory variables and arrive at a forecast for the dependent variable. Note that the regression model requires forecasts for the explanatory variables before it can forecast the dependent variable. Thus the quality of the forecast for the dependent variable is contingent on the quality of other forecasts. While this may appear to be a significant limitation, the forecaster can test the sensitivity of the demand forecast to alternative assumptions about the future levels of explanatory variables.

In contrast to regression-type models, derived demand models do not rely upon observed macroeconomic relationships between demand for electricity and other variables. Rather, they employ a microeconomic approach and derive the total expected demand for electricity from the "bottom-up". In the simplest form, demand would be equal to the number of users of electricity times the expected usage per user. On a more sophisticated level, the users of electricity are broken down into many different categories (e.g., residential, industrial, commercial) and the consumption per user category is divided according to the source of the consumption (e.g., consumption by heating systems, refrigerators, etc.). Detailed demographic data are employed to determine trends in population growth and consumption patterns. Regression analysis is often used to determine the nature of many of the microeconomic relationships. Therefore, the above comments relating to multiple regression analysis may apply to derived demand models.

(d) Level of Effort

Task Force (WCC)	$40,000
Liaison and Review (Acres)	2,000
Total Subtask 1.01	$42,000

(e) Schedule

Weeks 0 through 10

Subtask 1.02 - Development of Load Growth Scenarios

(a) Objective

Derive a range of realistic load forecasts for the Alaska Railbelt Region through the year 2005.

(b) Approach

This subtask will be subdivided into four further work packages:

- Analysis of Energy Demand
- Scenario Generation
- Development of Forecasts
- Preparation of Design Transmittal

These packages will be undertaken essentially consecutively, the transmittal being used for the basis of input for subsequent development of Subtasks 1.04 and 1.05 activities.

(c) Analysis of the Energy Demand

This work package will consist of a detailed energy demand analysis to identify the main macro and micro socioeconomic, political, and technological factors (the energy demand determinants) which influence long-term evolution of energy demand in each of the different economic sectors in Alaska Railbelt area (i.e., residential, industrial, commercial, resale, and governmental).

The factors which influence demand include population, load management efforts, the electric rate schedule, voluntary conservation and reduction in utility demand due to direct usage of other forms of energy (i.e., solar, wind, geothermal), as well as weather and outside economic influences such as the price of substitute fuels, electrical appliances and machinery that use electricity, employment, labor force, wages and income, taxable sales, housing permits, and building insulation and appliance-efficiency standards. The possibility of the introduction of electric transportation systems will also be examined. These variables are relevant to the economic theory of energy use either directly or as proxies for the more frequently encountered variables for which data may not be available.

(d) Scenario Generation

In this work package, scenarios will be built based on a set of consistent and plausible assumptions and the likelihood of their occurrence will be assessed.

The use of scenarios is essential, as clearly the future of a society cannot be forecast over a long period of time. As a general rule, the scenario method implies a consistent description of a systems evolution by fixing, through exogenous assumptions, the evolution of certain variables characteristic of this system -- the scenario components. The difficulty lies in the selection of these components and in the formulation of consistent assumptions. To cope with this problem, the scenario components are first selected among the energy demand determinants (which have been identified in the first subtask) and organized in a hierarchical structure derived from the determinants' structure. Each scenario is based upon assumptions about the basic determinants describing a consistent pattern of development for the Alaska Railbelt.

The scenario generation is comprised of three steps:

- Construction of a scenario base - i.e., the identification and structure of the scenario components. Three types of basic determinants can be isolated, among which there are dependence relationships:

  (i) determinants describing the long-run trends of society,
  (ii) determinants characterizing the overall policy of public authorities and therefore the long-term orientation of societal development,
  (iii) determinants related to the energy supply (supply constraints, energy prices, availability of other energy sources).

- Specification of the scenario path - i.e., the defining of assumptions based on the evolution of all components so as to describe the various economic conditions of the system over time.

- Assessing the likelihood of occurrence of the various scenarios. The probability of the scenarios are computed by combining the single event probabilities of changes in the determinants. Sensitivity analysis is conducted to test how changes in the probabilities influence the ranking of the scenarios.

(e) Development of Forecasts

The final work package involves running the forecasting model under the different selected scenarios. The scenarios with the highest probability of occurrence are run first. The sensitivity of the forecast to changes in the determinants of the scenarios are determined.

The results of running the model under different scenarios are combined in a systematic manner to give a probability distribution over base and peak loads. The range can be broken down into different segments and the probabilities over these segments can be computed.

For a given scenario, a load duration curve is constructed by plotting against time the number of hours during which system demand exceeds a given level. The system energy demand is measured by the area under the load-duration curve. Combined wih the probability distributions over the scenarios, the probability distribution over energy demand can be constructed both for the annual demand and typical weekdays and weekend days of each month.

(f) Preparation of Design Transmittal

The design transmittal will document the results of Subtasks 1.01 and 1.02 activities, the sources of information and data used in the development of load forecasts, and present a recommendation for load growth scenarios to be considered in the development of alternative expansion sequences in Subtask 1.04.

(g) Level of Effort

Task Force (WCC)	$85,000
Liaison and Review (Acres)	3,000
Total Subtask 1.02	$88,000

(h) Schedule

Weeks 8 through 26

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Subtask 1.03 - Selection of Power Alternatives

(a) Objective

Identify and select for evaluation purposes alternative power sources appropriate for inclusion in future Alaska Railbelt Region load-growth scenarios.

(b) Approach

This subtask will be subdivided into two further work packages:

- Non-hydro alternatives
- Hydro and tidal alternatives

These packages will be undertaken concurrently, non-hydro alternatives being developed by Woodward-Clyde Consultants, Anchorage and hydro and tidal alternatives by Acres American. Each package will include appropriate analyses to identify which (if any) energy sources would be viable alternatives to the Susitna Project. The evaluation will include an initial review of the March 1978 "Analysis of Future Requirements and Supply Alternatives for the Railbelt Region" published by Battelle Laboratories.

In deciding if a particular system or group of systems could be a viable alternative, five basic factors must be considered:

- Anticipated demand (location and amount) that the Susitna Project must supply,

- The maximum amount of power (or reduction in demand for power) that could be supplied to the Alaska Railbelt Region by each alternative,

- The cost per unit of electricity supplied by each alternative,

- Construction and licensing schedule of each alternative,

- The non-cost impact of implementing each alternative.

The intent will be to examine the widest possible range of alternatives while relying, as much as possible, on published data.

(c) Non-hydro Alternatives

The non-hydro alternatives to be examined include "traditional" energy sources such as coal or gas-fired steam turbines, combustion turbines (including combined cycle designs), diesel electric systems and nuclear power plants. (However, it is most unlikely that the nuclear alternative will receive serious consideration in Alaska) Studies undertaken to date for the Railbelt Region suggest that development of the Beluga and Nenana coal fields are likely to prove to be the largest viable alternative resources. Published data already developed by Woodward-Clyde Consultants on behalf of the Golden Valley Electric Association will be used in the proposed study. "Non-traditional" alternatives will include solar generation, wind, biomass, geothermal, and energy from wood and municipal waste. In addition, "non-structural" alternatives will be considered including time of day pricing, demand controls or more efficient use of existing system resources.

Consideration will also be given to the impact of possible changes in government policy with regard to uses of Alaskan natural gas, the possible "no-action" alternative and the construction of the Anchorage-Fairbanks transmission intertie alone, in lieu of the project.

(d) Hydro and Tidal Alternatives

The hydro alternative will not necessarily involve a single conventional hydro project and may consist of a group of smaller hydro projects with, for instance, a gas-turbine installation to provide firm capacity backup or some similar combination meeting the screening criteria--along with conservation measures which could serve to limit projected growth.

Within the Southcentral Railbelt of Alaska, the Susitna and Copper River drainage basins and other smaller rivers including Crescent, Chakachatna, Beluga, Yentna, Skiventna Chulitna, Talkeetna, Bradley (Creek) and Love were identified in the 1976 Alaska Power Survey by the Federal Power Commission as having significant conventional hydropower potentials. This study identified 23 projects, including Devils Canyon, Watana and Vee on the Susitna, with a potential installed capacity for all 23 sites of 8,419 megawatts. There are currently indications that the 70 MW Bradley Lake Project in the Kenai Peninsula may be developed in the foreseeble future. Current studies are also being undertaken by the Alaska Power Administration to identify "small hydro" potential.

The above references, in addition to other earlier work by the Bureau of Reclamation and Corps of Engineers and the most recent National Hydropower Study inventory by the Corps of Engineers, will be used to develop an overall scope of available hydro potential in the region. The sources will also be used to develop a specific alternative which could satisfy projected load demands at least as well as the Susitna Project. Published reports on the potential for development of the tidal power resources of the Cook Inlet Region will also be reviewed for consideration of this alternative.

(e) Discussion

This analysis of alternatives requires input from the task of forecasting electric load. The estimated demand, including amount, location and time distribution of demand, will be used as a basis for evaluating alternatives.

Concurrent with the demand estimation phase, an evaluation will be made of the amount of energy that can be supplied by each of the technologies considered. This will involve a preliminary review of the estimated amount of each energy resource available in Alaska, including such items as coal and oil reserves, solar, wind and tidal patterns and geothermal as well as other hydroelectric resources. The estimates for developing technologies will also include the availability date for commercial use. Preliminary cost estimates will be developed for each technology (cost/unit energy) based on the many existing studies (for example see "California Electricity Generation Methods Assessment Project", 1976). These cost estimates may vary with the amount of energy delivered, reflecting the necessity to use scarcer and scarcer resources.

The supply estimates for each alternative will be compared with the projected demand to determine what percentage of the demand each alternative can meet. It may be that some alternatives cannot supply any of the demand at reasonable cost. These can be immediately eliminated from consideration. Or, it may be that a technology is cost effective but cannot meet the total expected demand. In this case, several such technologies could be combined to make a single alternative system to compare with the Susitna project.

The most viable technologies (or groups of technologies) will then be reduced to a set of well-defined power generation alternatives for more detailed analysis. The analysis will include a detailed cost analysis of each alternative (still based primarily on published studies). This cost analysis will include capital costs (including transmission system), operation, maintenance and fuel costs, capacity factor estimation and potential for concurrent operations such as waste heat distribution. The emphasis will be on consolidating and correlating information from various sources to allow a consistent comparison of alternatives.

A scheduling analysis will be conducted to determine when the technology(s) for the alternative will be available and what leadtimes are necessary for construction. Finally, a comprehensive evaluation will be made to identify the non-cost impacts of each alternative. These impacts are likely to include environmental impacts (air quality, water quality and ecology); public health and safety impacts; socioeconomic impacts (such as a "boom-bust" cycle of population during plant construction); and the licenseability of specific alternatives to the extent that no insurmountable legal or environmental barriers are evident.

Non-cost concerns will be organized into a set of attributes for measuring the overall desirability of each alternative and combined with cost and scheduling concerns to evaluate each alternative.

These attributes will be designed to cover the range of identified concerns while not overlapping with one another. Each attribute will have an associated scale (or measure) to identify the level of achievement of each alternative with respect to each attribute.

Scales will be designed to be meaningful to decision makers and to be measurable using existing data as much as possible. If no natural scale (such as dollars for the cost attribute) exists, constructed (judgmental) scales will be used. The results of this analysis can be presented in a matrix showing the level achieved on each attribute for each alternative.

(f) Level of Effort

Task Force (WCC)	$65,000
Task Force (Acres)	20,000
Task Force (TES)	10,000
Liaison and Review (Acres)	2,000
Total Subtask 1.03	$97,000

(g) Schedule

Weeks 20 through 35

Subtask 1.04 - Selection of Viable Expansion Sequences

(a) Objective

Determine the total system costs of selected future Railbelt Region expansion sequences, both with and without incorporation of the Susitna Hydroelectric Project, and rank the preferred generation expansion scenarios.

(b) Approach

The most straightforward method of evaluating the potential economic benefit of a hydroelectric project in a given system expansion scenario is to compare capital investment and system operating costs on an annual basis, throughout the term of the study, for two scenarios: one without the benefit of the proposed hydro project; the other with it.

A number of mathematical models are available to facilitate the vast number of calculations involved in this type of study. In simplified terms, the user of such a model provides the program with data which includes the characteristics of the forecasted load and the characteristics, availability and costs of generation sources which will be available throughout the period of the study. The model then selects the generation sources available to it to satisfy the projected load in the most economical manner.

To evaluate the economics of a given project, a comparison may be made of total annual costs of the two system scenarios on a year-by-year basis throughout the study period. If the system with the hydro project available is less costly throughout the planning period, the project is obviously attractive. Conversely, if this system is more expensive in all years, then the project is unattractive.

It is possible, indeed likely, that the outcome of an economic evaluation would prove not to be so clear cut. It may be that the system incorporating the hydro plant would be more expensive in some years of the study, and less expensive in others, than the system without that project. In this situation, it would be necessary to perform comparisons between present worth values of operating costs for systems represented by the two scenarios.

Although such a strategy may provide a valid economic comparison, the results may be inconclusive. This is likely to occur in the case of a hydro project which has a capacity which is relatively small when compared to its connected system. The economic comparisons then may be a relatively small difference in two very large numbers.

(c) Selection of Model

In the search for a usable generation planning computer model, three characteristics of the model are paramount:

- Flexibility -- does the model allow for a varied combination of alternatives?
- Accessibility -- is the model presently available and can it be used with a minimum of learning time?
- Reliability -- is the model actively maintained by its supplier and has it been used by other utility planners?

A preliminary survey of the market has revealed one model which satisfies all three criteria. Other models may be available, but these are generally developed either by or for specific utilities to solve their particular problems or they are so intricate so as to require special training in their use.

The computer model selected by Acres for this study is the General Electric Optimized Generation Program, Version Five (OGP-V). Acres' staff are familiar with the use of this program on other studies similar to the Susitna alternatives evaluations. The model is currently in use for the evaluation of small hydro sites in the eastern U.S. Earlier versions of the model, OGP-III and OGP-IV were used in studies performed for the U.S. Army Corps of Engineers in evaluating alternatives for New England Power Supply scenarios through the year 2000. This study was part of the Environmental Impact Statement for the proposed 944 MW Dickey-Lincoln School Lakes Project in Maine.

Development of input data and operation of the OGP-V model is unavoidably costly and time-consuming. Thus, to facilitate the initial development of viable expansion mix scenarios, use will also be made of an Acres in-house "Generation Planning Program". The results of this initial analysis will permit the preliminary ranking of alternative generation expansion sequences in order of economic preference. Tests will be undertaken at this time on the preferred expansion sequences in order to check the sensitivity of the economic ranking to variations in:

- load demand forecast
- capital cost estimates
- fuel cost escalation
- discount rate.

As a result of this analysis, it will be possible to prepare a "short list" of preferred generation expansion sequences for more detailed analysis using OGP-V.

(d) OGP-V

The OGP-V program combines three main factors of the generation expansion planning decision process: system reliability evaluation; operations cost estimation; and investment cost estimation. The program begins by evaluating the power system reliability in the first study year by means of one of two methods -- either a percent reserves calculation or the computation of the loss of load probability (LOLP).

When the system demand level rises to the point at which either the user-specified reserve level or the LOLP criteria is violated, the program "installs" new generating capacity. The program will add generation capacity from a user-provided list of available sources. As each possible choice is evaluated, the program carries out a production cost calculation and an investment cost calculation, and eliminates those units or combinations of units whose addition to the system results in a higher annual cost than other units or combinations. The program continues in this manner until the least-cost system addition combination is determined for that year. In cases where operating cost inflation is present, or where outage rates vary with time, OGP-V has a look-ahead feature which develops levelized fuel and O&M costs and mature outage rates out to ten years ahead of the "present" time. Once the apparent least-cost additions to the system necessary to satisfy reserve or LOLP criteria have been established, the process is repeated for the next succeeding year of the study.

(e) Discussion

Load forecasting and daily load variation data generated in Subtask 1.02 will be used as input to the computer model together with the following technical and economic planning criteria:

- generation capacity and energy reserve requirements
- retirements of older units
- cost of money
- economic discount rate
- insurance and tax rates
- economic lifetime of equipment
- effects of cost escalation
- period of analysis

This data will be established in consultation with Alaska Power Authority, other utilities in the Railbelt Region and other pertinent agencies. Some of the above parameters, such as the discount rate, and perhaps cost escalation, will be determined as base rates with a possible variation over a given range. The analysis will be carried out at the base rate with sensitivity testing over the possible range for selected alternatives.

One of the benchmarks against which the economics of a power generating facility may be measured is the economics of its alternatives. In many cases, it is possible to identify specific alternatives against which a given project may be directly compared. Most generating projects are intended for a specific operating regime within the power system, such as base-, intermediate-, or peak-load operation. For such sources, it is a relatively straightforward task to evaluate the cost of operating a specific alternative.

Hydroelectric projects, due to their hydrologic characteristics, must be evaluated in a somewhat different manner. A hydro project can be subject to significant seasonal variations in its generation capacity. Factors such as rainfall patterns and springtime snowpack runoff can work to make baseload and peaking benefits available from the same hydroelectric project. Also, although initial studies of the Devil Canyon-Watana installations were based upon a fifty percent annual capacity factor (1,394 MW, 6,100,000 MWh/yr), some base-load (greater than 80 percent capacity factor) and some peak-load (less than 10 percent capacity factor) energy can be expected to be available. The way in which such additional capacities become available complicates the evaluation of a hydroelectric project.

Conventional base-load plants such as coal-fired or nuclear steam plants are commonly built to take advantage of the economies of scale available to large plants of this type. Conversely, peaking plants are usually relatively small (less than 100 MW). The base-load energy produced by even a large hydro plant may be available only at such a small capacity as to make comparison with the conventional alternatives meaningless. For example, if the Susitna project, with its 1,394 MW output at 50 percent can produce only 125 MW at capacity factors greater than 80 percent, it is difficult to make comparisons with base-load nuclear or coal plants with capacities on the order of 500 MW or larger. In the same sense, hydrologic conditions may make a great deal of capacity available at a given site for very short periods of time as peaking energy. Such large amounts of surplus energy may make meaningful comparisons between the hyro project and its conventional alternatives (combustion turbines) difficult.

Thus, the Susitna Project will be evaluated in the light of its effect upon the mix of alternatives in the power system and any possible deferment of capital expenditures for other facilities. To properly take into account the capacity variations of the project, its operation within a power system will be analyzed on a monthly, or at least a seasonal, basis. More detailed analyses could be performed to define exact operating procedures, but such detail is not justified in a long-term planning study.

(f) Level of Effort

Task Force (Acres) $30,000

(g) Schedule

Weeks 26 through 40

Subtask 1.05 - Expansion Sequence Impact Assessments

(a) Objective

Compare from an environmental standpoint, the consequences of developing the selected alternative expansion scenarios in the Alaska Railbelt Region, including historical, socioeconomic and other factors.

(b) Approach

The approach to review and assessment alternatives will be to primarily utilize existing data, and available aerial photography of the selected or potential source sites whenever and wherever sufficient information is already available. However, it may be necessary to gather limited site-specific data for the assessment, since the environmental resources of many of the more remote portions of the study corridor have not been inventoried. The key to this approach is the use of staff who have an in-depth knowledge of both fish and wildlife habitat requirements and the short-term and long-term effects of impact-producing actions of construction and operation of various facilities in Alaska.

The environmental consequences of developing alternative energy sources are highly dependent upon numerous factors including energy resource, collection method, site location characteristics, site fish and wildlife characteristics, land-use patterns, and facility construction and operation designs. A thorough assessment of the impacts of optimum generation expansion mixes is also dependent upon an understanding of the habitat requirements of local fish and wildlife during their life history; a knowledge of limiting habitat factors; and sensitivities such as fish overwintering areas, and nesting and feeding habitats of endangered or threatened fauna.

The significant impact-producing actions will vary with the alternative being assessed. At times, the selected site location will be the prime factor, while for other alternatives, the short-term or long-term air quality or water quality perturbations, or wildlife habitat degradation may be the overriding factor. Some of the more significant potential concerns are discussed below.

The environmental evaluation of the selected hydroelectric and tidal power development alternatives (if any) will identify the associated potential impact issues, and their relative magnitudes. Such issues will involve the relative sizes of reservoirs and impacts on water quality and fish and wildlife habitats in particular. The environmental analysis will be performed on the basis of available data, which will be compiled for this purpose. For the Task 1 studies, the comparative impact issues associated wtih the Susitna Project already identified in the current Corps of Engineers EIS, will be used as the yardstick against which all other alternatives will be measured. Transmission facilities associated with the hydro alternative sites will be included in this environmental analysis.

The intensity of analysis required for comparison of the hydroelectric alternatives will be less than that required for the primary alternative. Field investigations will not be undertaken to identify the potential magnitude of impacts of the alternatives.

With coal-fired power plants, such as those associated with the Beluga and Nenana fields, the collection of large quantities of coal through surface mining would create environmental concerns. These concerns are related primarily to large-scale, long-term habitat alterations affecting fish and wildlife. The operation of coal-fired plants would also create problems relating to air quality, cooling water discharges, and run-off from fly ash ponds. However, plants can be designed to successfully mitigate these concerns.

New gas or oil-fired power plants require construction of pipelines that at least lead to short-term concerns associated with river crossings, wetlands disturbance, and habitat alterations. On-site facilities can cover large acreages, and operation can create air quality problems related to nitrogen emissions and winter steam plumes.

Wood-produced energy would also cause air quality problems such as those currently found in the Fairbanks area. Such plants would furthermore require clear-cutting of vast acreages of timber. This is not considered environmentally wise due to the slow regeneration times required for timber production and hence would lead to long-term wildlife habitat alterations. Potentially severe impacts to stream habitats and local fish populations would also result.

(c) Land and Water Use

Land ownership in the vicinity of the alternatives will be identified as federal (including agency jurisdiction), state, private and Native Corporation. Land ownership status may be in transition due to the Alaska-Native Claims Settlement Act and State Selection under the Statehood Act. Land management plans and regulations affecting alternatives will be evaluated. The various federal and state agencies, and some Native Corporations will have land classification and management systems governing activities that are allowed on those lands and waters being managed. Stipulations concerning allowable activities could affect the feasibility of alternatives to Susitna. Land and water use patterns (historical, current and proposed) will be documented in order to evaluate impacts and potential use conflicts posed by Susitna alternatives.

Unique features in the vicinity of alternative projects, such as recreation areas and aesthetic/visual resources, also will be identified. The presence of popular recreation areas or unusual aesthetic quality may present impact and feasibility problems, particularly when on public lands.

(d) Socioeconomic Characteristics

Demographic data, historic, current and projected, will be evaluated to estimate the impact created by the influx of construction and operations work forces. Employment characteristics of the work force in the vicinity of alternative projects will also help evaluate positive and negative impacts created by project implementation. This information would include employment and unemployment by region and skill classification, and wage rates (also regional and skill specific).

Financial characteristics of any borough or municipal governments in alternative project areas will be considered. Tax revenue, mill rates, and tax base data will help estimate potential impacts. Housing characteristics, such as available stock (including rental units) and vacancy rates, will be utilized for impact evaluation. Community infrastructure could be impacted by implementing alternatives to the Susitna project. Current loads on infrastructural systems (i.e., electricity, water, sewage) service areas, and system capacity will therefore be considered.

Transportation systems potentially affected by project alternatives will be identified. Data will include current traffic estimates, capacity, area of service, and intermodal connections.

Sociocultural characteristics could be an issue in several project areas. Life style, ethnic traditions and subsistence use patterns of biological resources will be documented.

(e) Archaeological and Historical Resources

Existing archaeological and historical sites will be inventoried in alternative project areas, as available data allow. The State Historical Preservation Office maintains a statewide file of known sites and will be utilized in this effort.

(f) Level of Effort

Task Force (WCC)	$ 90,000
Task Force (TES)	45,000
Liaison and Review (Acres)	3,000
Total Subtask 1.05	$138,000

(g) Schedule

Weeks 30 through 45

Subtask 1.06 - Power Alternatives Study Report

(a) Objective

Prepare power alternatives study report for Susitna Hydroelectric Project.

(b) Approach

The power alternatives study report will address:

- Load forecasting for the Railbelt Region
- Selection of alternative energy and/or power generation scenarios
- Evaluation of viable expansion sequence scenarios
- Recommended expansion sequence

The report will document the findings of Subtasks 1.01 through 1.05 and incorporate the transmittal prepared under Subtask 1.02.

(c) Discussion

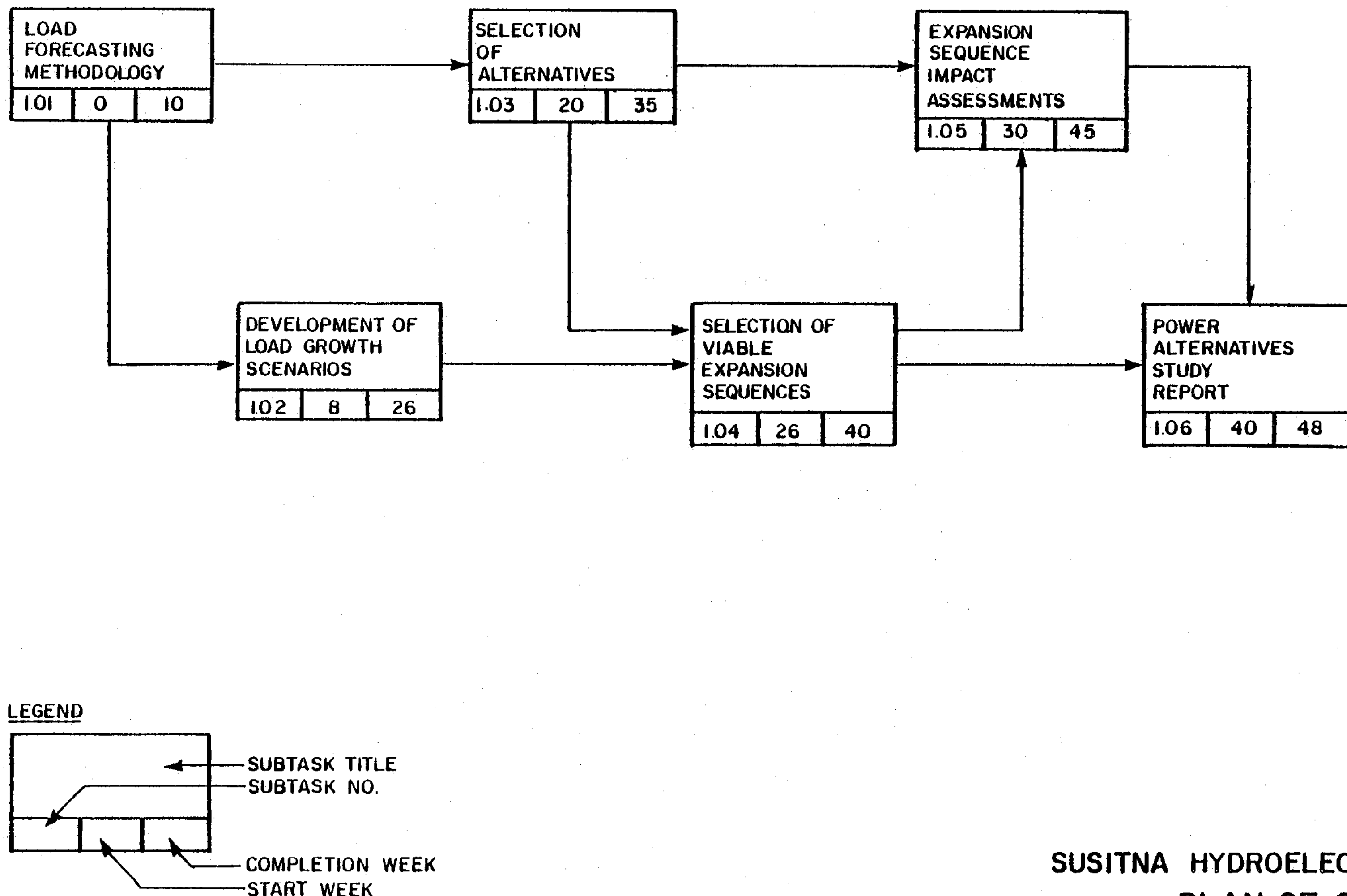
This report will seek to address the fundamental issues of the "need for power" and selection of the optimum future Railbelt Region electrical power supply scenario through the year 2005. If the Susitna Project is to be justified as a viable and licensable development, this report has to provide the fundamental basis for such justification. The report will initially be prepared in draft form for submission to Alaska Power Authority for review, and subsequently made available to all concerned parties for comment and discussion under the Task 12 Public Participation Program.

(d) Level of Effort

Task Force (Acres) $12,000

(e) Schedule

Weeks 40 through 48



ACRES

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T1.1: TASK 1 LOGIC

TASK 2: SURVEYS & SITE FACILITIES

A.5.3 - TASK 2: SURVEYS AND SITE FACILITIES

(i) Task Objectives

To provide for safe, cost effective, and environmentally acceptable logistical support of all project field activities; to conduct those surveys necessary to furnish data for use in other subtasks which must be performed prior to licensing; to resolve real estate issues associated with the proposed project in sufficient detail to permit preparation of Exhibit F of the FERC license application; and to undertake initial studies of proposed reservoir areas and access roads.

(ii) Task Output

The primary outputs of this task will be major portions of certain exhibits required for FERC license application and data which will be necessary inputs for many of the remaining exhibits. Specifically, this task will contribute to Exhibit D (demonstrating evidence of compliance with State water and land use laws), Exhibit E (providing water rights data and plans for perfecting rights to use water for project operation), Exhibit F (statement of land ownership). In addition, surveys and mapping will be essential portions of Exhibit J (general project map) and Exhibit K (detailed project map showing boundaries, survey data, land ownership, and feature locations). In addition to the data collection and exhibit preparation, a number of tangible products will be acquired or constructed and will generally be suitable for use during the post- application phase and beyond. In this latter category are included camp facilities, airfield, and similar semi-permanent items.

(iii) List of Subtasks

Subtask 2.01 - Provision for Land Use Payments and Directed Inspection Services

Subtask 2.02 - Provision of Field Camps and Associated Logistic Support

Subtask 2.03 - Design and Construction of Airstrip

Subtask 2.04 - Land Status Research

Subtask 2.05 - Land Acquisition Analysis

Subtask 2.06 - Right-of-Entry

Subtask 2.07 - Site Specific Surveys

Subtask 2.08 - Aerial Photography and Photogrammetric Mapping

Subtask 2.09 - Control Network Surveys

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Subtask 2.10 - Access Roads

Subtask 2.11 - Map and Photo Search

Subtask 2.12 - Field Reconnaissance of Reservoir Areas

Subtask 2.13 - Marketability and Disposal Study for Reservoir Area

Subtask 2.14 - Cost Estimates for Reservoir Clearing

Subtask 2.15 - Slope Stability and Erosion Studies

Subtask 2.16 - Hydrographic Surveys

(iv) Subtask Scope of Statements

Section A.4 of this plan of study provides a logistical plan describing measures, procedures, considerations, and responsibilities incident to the conduct of effective logistic operations. Subtasks 2.01 through 2.03 are generally concerned with implementation of field operations under that plan in a safe, economical, and environmentally acceptable manner. Task 13, Administration, provides for an in-state project office as the essential link between field operations and concurrent efforts to be undertaken in Alaska and elsewhere. This project office will not only facilitate essential procurement, communication, and coordination of logistical support, but also it will ensure that data generated in the field is properly and expeditiously routed to various points where it will be processed, interpeted, and evaluated.

Subtasks 2.04 through 2.06 deal with real estate aspects. It is by no means clear at the time of preparation of this plan of study just which of several land interests will predominate at any given stage in the study process. Thus, it is all the more essential that careful attention to real estate details be paid early and continuously.

Land survey activities are generally provided for in Subtask 2.07 through 2.09 and hydrographic survey in Subtask 2.16. Only such mapping and control as is necessary for license application will be accomplished in the initial 30 months after notice to proceed is given. It follows, then, that some survey activity may be expected to occur in succeeding months prior to granting of the license.

Subtasks 2.10 through 2.15 deal in general with lands whose current conditions will be permanently changed in the event that the proposed project is ultimately constructed. Technical implications of actual conditions discerned along alternative access roads and within potential reservoir areas are assessed in this group of subtasks. Surveys and route selection studies associated with transmission lines are separately provided for under Task 8.

It is clear that a certain risk is associated with incurring the relatively large expenditures in accomplishing this task.

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It is entirely possible that concurrent efforts dealing, for example, with possible alternatives under Task 1 or environmental impacts under Task 7 may lead to a decision at the end of the twelfth month to abandon the Susitna Hydroelectric Project in favor of some other choice or combination of choices for satisfaction (or, indeed, if appropriate, consciously forcing growth limits through nonsatisfaction) of forecasted load requirements. We will minimize the risk insofar as practicable by delaying those field subtasks which can reasonably be delayed as long as possible without jeopardizing plans for filing the FERC license application by mid-1982.

Subtask 2.01 - Provision for Non-Discretionary Payments

(a) Objective

Make explicit provision for certain budget items not subject to discretion of the engineer.

(b) Approach

Several budget items are included in this plan of study to account for APA's directions in that regard. Specifically, the costs noted in subparagraph (d) below account for land use payments to affected Native Corporations in the amount of $36,000 per year, full time inspection services to protect native interests in the amount of $3,000 per month, and funds for study coordination and review by APA in the amount of $100,000 per year.

(c) Discussion

The APA Request for Proposal, dated June 25, 1979, directed that the above items be included. The requirement to fund a full time Susitna Coordinator in the Alaska Department of Fish and Game and to set aside $1 million for an independent cost estimate and seismic risk analysis is accounted for elsewhere in this plan of study.

(d) Level of Effort

Land Use Payments......................$90,000
Full Time Inspection...................$90,000
Coordination and Review (APA).........$250,000

Total Subtask 2.01....................$430,000*

(e) Schedule

Throughout entire period.

* These directed costs are entered as a separate item from other costs listed in cost tables at other points in the study.

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Subtask 2.02 - Provision of Field Camps and Associated Logistic Support

(a) Objectives

Provide acceptable living accommodations for assigned field personnel and necessary visitors and provide a base for field operations in the most economic and efficient manner.

(b) Approach

There will be two camps, a permanent base camp at Watana and an overflow camp at Devil Canyon. All the design work and the procurement of modular units and attendant life support system (power plants, water plant, sewage treatment plant and communications system) will be done immediately after contract award. The Watana camp will be sized to accommodate a maximum of 60 people and its layout will be based on previous camps designed for Alaskan conditions. This "off the shelf" approach will help reduce costs. The modular units and equipment for both the Watana and Devil Canyon camps will then be transported overland from Denali Highway to the Fog Lake area. The Watana camp will be erected in late February, 1980 and operations will begin by March, 1980. This camp will be the main base of field operations as well as the point of in-depth study of the Watana site and the surrounding area.

The equipment for the 20-man Devil Canyon tent camp will be transported in May by helicopter from the Fog Lake area and the camp will be fully operational by June, 1980. This camp will provide temporary housing for crews working in the area.

The Watana camp will be operated and maintained on a continual basis from March, 1980 through June, 1982. The Devil Canyon camp will be occupied as required by the field support schedule (June through September, 1980 and 1981). This camp will be moth-balled during the time the camp is not being utilized.

The Watana camp will be constructed from 33 10' x 24' modular units and will have complete water and sewer treatment systems. It will have warehouse, shop, recreational, office, food service, laundry, and fuel storage facilities. It will also have sheltered electrical generators and an incinerator. The dormitory, food service, and recreation buildings will be interconnected with Arctic walkways.

The Devil Canyon camp will consist of ten 2-man tents and a kitchen tent, all with wooden floors. There will be showers and incinerator toilets (no sewer treatment plant), electrical generators, a water system, and food storage and fuel storage facilities.

A variety of cost comparison alternatives will be evaluated prior to start of field operations. Should any of these alternatives be found to be cost effective, they will be included in the field plan. The alternatives to be evaluated include:

(1) Utilizing the High Lake Lodge in place of the 20-man tent camp at Devil Canyon.

(2) Transportation of camp modules by Hercules Aircraft in lieu of overland cat-train (two sub-alternatives will be evaluated -- truck or rail transportation to Palmer or Talkeetna, then air transportation to the site versus direct air transport from Anchorage to Fog Lake Site).

(3) Utilization of Arctic type sewage treatment plant, with chlorinated effluent, in lieu of a sewer treatment plant with a lagoon system for waste water effluent. This approach will depend upon obtaining the necessary permit for the Arctic type plant.

(4) Utilizing Fog Lake as the water supply in place of drilling a water well.

(5) The elimination of some or all the Arctic walkways and reconfiguring the camp to minimize exposure to the most severe ambient conditions.

(6) Burying solid waste instead of incineration if the proper permit can be obtained.

A potential way to reduce program cost is through a consolidated logistics effort. Consolidated logistics management would insure the minimal utilization of supply aircraft and vehicles, consistent with the field schedule and quantity of materials to be transported. We will continuously monitor and adjust the overall logistics operation to minimize costs and environmental disruption. The principal Acres representative (Chief Engineer for Alaskan Operations--CEAO) will have responsibility and authority for such efforts and may, if economics can be effected thereby, designate a single logistics manager from within the Acres team.

(c) Discussion

It will be noted that meeting the planned FERC application target at 30 months after notice to proceed requires the earliest possible commencement of field operations. Certain key assumptions implicit in our plan for establishment of a permanent camp near the Watana damsite prior to break-up include the following:

(1) Funds will be made available immediately after contract award to permit expedited procurement of "long lead" items.

(2) The important requirement for archeological reconnaissance and associated clearances prior to disturbing natural conditions generally cannot be satisified until snow cover is gone from the proposed camp area. We assume that the first stage camp construction and initial operation will be conducted in areas previously checked out for earlier Corps of Engineers activities. Only so much of the semi-permanent camp near Watana as can be erected on archeologically cleared land will be installed initially. Remaining modules and supplies to be brought in while the ground is frozen will be stored until after break-up. Archeological reconnaissance to permit expansion will be undertaken as a matter of priority as soon as conditions are favorable for that work.

(3) Ownership for project lands will have been transferred to Cook Inlet Region Incorporated prior to commencement of field activities.

(4) The cooperation of various permitting agencies and organizations in expediting necessary early permits will be secured.

The camp accommmodation requirements in a remote Alaskan environment cannot be underestimated. The size of camp proposed has been determined as the minimum size necessary to undertake the required field work (surveys, geotechnical exploration, hydrologic and seismic monitoring, and environmental studies) in the proposed time frame. The experience and knowledge of the Acres - R&M - Moolin team in preparing estimates for camp requirements is unrivalled.

The capital cost of erecting a semi-permanent camp capable of accommodating peak loads of 60 people or so and average loads of 40 to 50 is significant. Whereas the initial contract will cover a period of only 30 months, it may be anticipated that field activities will be required on a continuous basis for some years after license application is made. Thus, for purposes of fairly allocating costs, the estimated level of effort provided in subparagraph (d) below allows for transferring a salvage value (at the end of the first 30 months) to the follow-on contract.

(d) Level of Effort

Camp Facilities and Operations (CIRI/H&N).......	$2,953,600
Air Transportation (FMA)........................	$ 510,000
Fuel (CIRI/H&N).................................	$ 290,000
Coordination and Management (Acres)*...........	-------
Total Subtask 2.02.............................	$3,753,600

(e) Schedule

Throughout project period.

* These costs have been included in Task 13 (Administration).

Subtask 2.03 - Design and Construction of Airstrip

(a) Objective

Provide responsive and reliable resupply and emergency service capability with minimum environmental degradation.

(b) Approach

During the earliest stages (the initial winter months) an accessible frozen lake will be cleared to allow access to the study site by Hercules aircraft. As soon as conditions permit and archeological reconnaissance is conducted, construction of a 5,000 foot gravel airstrip will commence.

Early development of a properly sized and designed Airstrip is expected to expedite subsequent operations at the project site. Site selection can best be obtained through a repetitive process of evaluation, beginning with several alternatives and eliminating those that do not meet the necessary requirements.

The scope of work during this portion of work will be by Airphoto study, aided by evaluation of existing boring logs and topographic maps. A field check of this study will be made prior to making the final site selection of the Airstrip site. The design phase is envisioned as being completed in three stages. The initial stage will consist of providing tentative drawings for the Airstrip and related facilities, such as access roads to material sources needed in its construction. The subsequent phase will provide drawings suitable for construction purposes as well as a cost estimate for the construction of the facility. The final design stage will be to provide the planning and instrumentation of temporary transportation facilities while the Airstrip is unserviceable, primarily before and during construction. This final design procedure is necessary to reduce the overall project time from the Notice to Proceed and the time a full scale work effort can be accomplished.

Time dependent requirements such as permits, wind direction information, archeological studies, and the stockpiling of initial construction supplies will therefore be started as soon as possible.

The Airstrip will continue to function after FERC license application has been made. Indeed, assuming that the project is shown to be viable, the Airstrip will continue to serve throughout the period during which the proposed dam is constructed (and beyond that, perhaps during operation of the project some years hence). It follows that design, arrangement, and construction will be accomplished in such a way that later expansion or permanent surfacing will be possible.

(c) Discussion

The cost and efficiency of work crews, as well as their safety is dependent on providing proper equipment and manpower at the work site. The objective in providing an Airstrip at the location of work is to provide these support facilities in such a way that will minimize degrading the existing environment. Consideration of adverse environmental consequences will be evaluated during the site selection as well as the size and usage requirements for efficient operations.

Because of land use restrictions limiting overland access (to the proposed semi-permanent camp facilities) to those months when snow cover and frozen conditions exist, it will be essential to provide for resupply and emergency evacuation by air. The use of helicopters for such purposes is extremely costly and weather conditions prevent helicopter access far more often than that for fixed wing aircraft. (The Corps of Engineers' experiences during their most recent drilling efforts at the Watana site demonstrated that a high number of non-flight days accrued when helicopters were relied upon exclusively. On the other hand, the successful use of Hercules aircraft during construction of the Trans Alaska Pipeline System (TAPS) clearly demonstrated the reliability and responsiveness of that approach). The Acres team is unique in the sense that the only Hercules aircraft now operating in Alaska are under the direct control of Frank Moolin Associates and its sister company. Thus, the Susitna Hydroelectric Project Studies will benefit from the strong experience gained during the TAPS support efforts.

The proposed Airstrip bears a remarkable similarity to the type which certain military engineer battalions must be capable of constructing in conjunction with military operations. Yet, military engineers seldom have the opportunity to practice such projects in truly remote, harsh climate regions because land use restrictions and environmental concerns frequently preclude such activities. Because the proposed Susitna project will be undertaken by the State in the interests of the public, there appears to be no legal constraint associated with permitting military engineer units to actually undertake design and construction of the Airstrip. We will explore this alternative as a possible cost reduction measure.

(d) Level of Effort

Task Force (R&M)............................$100,000
Coordination and Review (Acres).............$ 10,000

Total Subtask 2.03..........................$110,000

(e) Schedule

Weeks 1 through 26

Subtask 2.04 - Land Status Research

(a) Objectives

Identify ownership and other interests in and adjoining the project area and associated transmission corridors and provide information needed for power project planning, land acquisition analysis, and for obtaining rights-of-entry to conduct field studies.

(b) Approach

Ownership information will be gathered from the tax assessor and land recorder, BLM, the State Division of Lands, and Native Corporations. Lands will be categorized by general ownership category (private land, State land, U. S. land, and Native land) and status maps at an appropriate scale will be prepared. Other factors affecting land status, such as third party rights, State or Federal agency designations, or limited interest rights will be indicated.

(c) Discussion

Cook Inlet Region, Inc. has already collected a substantial portion of the information required. The cost of completing this task will be reduced substantially because this information and the corporation's land status research capability will be utilized.

(d) Level of Effort

Task Force (CIRI/H&N)	$15,000
Coordination and Review (Acres)	$ 1,000
Total Subtask 2.04	$16,000

(e) Schedule

Weeks 0 through 15

Subtask 2.05 - Land Acquisition Analysis

(a) Objectives

Identify lands which must be acquired or for which right-of-way permits or easements must be obtained and estimate land acquisition costs and right-of-way permitting requirements.

(b) Approach

Once plans for the siting of all elements of the power project have been developed, a detailed inventory of private and public lands on which facilities are to be built will be prepared. Each private land owner will be identified and the amount and market value of land to be acquired by either easement or purchase will be estimated. The amount of public land required will be broken down by agency land holder and an estimate of the cost of right-of-way permits will be made. Evidence of title will be secured as needed. All third party rights will be identified and evaluated in terms of impact on acquisition costs.

(c) Discussion

Cook Inlet Region, Inc. has already collected a substantial portion of the information required. The cost of completing this task will therefore be minimized.

(d) Level of Effort

Task Force (CIRI/H&N)....................$10,000
Coordination and Review (Acres)..........$ 500

Total Subtask 2.05.......................$10,500

(e) Schedule

Weeks 8 through 20

Subtask 2.06 - Right-of-Entry

(a) Objectives

Provide the information needed to obtain right-of-entry to private lands as required for reconnaissance, surveying, and other field investigations; acquire necessary rights-of-entry.

(b) Approach

On the basis of the overall field plan, the private lands to be entered will be determined and the appropriate land owners will be identified.

Permits required for entry and use of public lands will normally be obtained by CIRI/H&N in response to requirements of individual investigating teams.

(c) Discussion

Obtaining rights-of-entry will more efficiently be accomplished when done by one project associate rather than by each individual team member. This will also assure that the needed rights-of-entry have been obtained and that no trepass occurs. And beyond that, of course, it provides a positive means to ensure that redundant applications are not filed--an important consideration to permittor and permittee alike.

(d) Level of Effort

Task Force (CIRI/H&N)	$15,000
Coordination and Review (Acres)	1,000
Total Subtask 2.06	$16,000

(e) Schedule

Throughout project period with most emphasis during initial six months.

Subtask 2.07 - Site Specific Surveys

(a) Objective

Provide "on the ground" surveys of specific areas which require a higher level of accuracy than can otherwise be obtained through photogrammetric mapping.

(b) Approach

Two field surveyed cross sections will be obtained at each dam site consisting, essentially, of an accurate profile perpendicular to the river on a predefined axis.

The site survey of the Airstrip will be conducted using conventional survey techniques to establish topography of such accuracy as to allow construction plans to be prepared. This activity includes the construction lay-out surveys for building of the Airstrip.

The site survey will be required of the temporary camp to facilitate design of the camp, sewage disposal system and water supply. This activity is covered under Subtask 2.02.

A site survey at each dam site will be conducted "on the ground" at a location contemplated for switchyards-transformer pads to facilitate the design of those facilities but will not require construction staking during this study phase.

(c) Discussion

These site specific survey efforts will augment photogrammetric mapping. They must be conducted reasonably early in the study process since the results will be required for subsequent design studies and field construction of certain temporary facilities. Crews involved in the work will be furnished lodging and air transportation, the costs for which are separately included under Subtask 2.02. The long experience of R&M Consultants, Inc., in similar work throughout the State has resulted in R&M's acquisition of equipment tailored for use in remote, harsh environments as well as in the develop of field procedures well suited to the instant requirement.

(d) Level of Effort

Task Force (R&M).......................$60,000
Coordination and Review (Acres)........$ 3,000

Total Subtask 2.07.....................$63,000

(e) Schedule

Weeks 9 through 12, and 22 through 26

Subtask 2.08 - Aerial Photography and Photogrammetric Mapping

(a) Objective

Provide contour mapping of both Devil Canyon and Watana Dam and Reservoir sites, photography and contour mapping of access corridors, photography of transmission corridor, photography to be used by geologists in terrain unit mapping, photography to be used in the environmental studies of the project area and photography of the Susitna River downstream to Talkeetna for use by hydrologists.

Approach

Partial mapping of the Watana Dam Site has previously been accomplished through efforts of the Army Corps of Engineers. Photography exists on the Devil Canyon Dam Site but no contour mapping has been accomplished.

The Corps of Engineers' effort, as stated above, will be evaluated and augmented, as required, by additional mapping of the dam sites at a scale of 1" = 200' with a contour interval of 2 feet.

The reservoir sites, camp and airport sites, switchyard sites, access corridors, transmission corridor and lower Susitna River downstream to Talkeetna will be paneled (targeted), survey tied to horizontal and vertical control and aerial photographed. Contour mapping by photogrammetrical methods will be performed at a mapping scale of:

Watana and Devil Canyon Reservoir Sites---1" = 400' with 10' contours
Watana and Devil Canyon Dam Sites---------1" = 200' with 2' contours
Alternative Access Routes-----------------1" = 400' with 10' contours
Field Camp and Airstrip-------------------1" = 400' with 10' contours

Certain activities essential to eventual detailed design will be deferred until after license application has been filed. These include contour mapping by photogrammetrical methods at mapping scales of:

Switchyards-------------------------------1" = 200' with 5' contours
Selected Access Route---------------------1" = 200' with 5' contours
Selected Transmission Route---------------1" = 200' with 5' contours

The lower Susitna River and transmission corridor will be photographed and photogrammetrically profiled prior to license application but no contour mapping is anticipated until later in the program.

All aerial photography that is to be used for contour mapping of 1" = 200' must be taken during the spring or fall of the year when snow is not present on the ground and when deciduous vegetation is without leaves. Fortunately, the pre-application requirements in this area are relatively modest.

Existing contour mapping previously performed by the Corps of Engineers must be correlated to accurate vertical datum as current datum used was determined from V.A.B.M. (Vertical Angle Bench Mark) and is only accurate to plus or minus 15 feet.

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(c) Discussion

The aerial photography and mapping program described herein is considered the minimum necessary to satisfactorily prepare necessary exhibits for FERC license application. Even so, the costs of such efforts are not insignificant. Thus, any additional measures which may serve to further reduce costs are important. In this regard, we will make a detailed and comprehensive assessment of all photography flown to date by the Corps of Engineers and others to ensure that duplication of previous efforts does not occur.

We are aware that some unprocessed aerial photographic data has been collected in the past two years by the Corps. Its usefulness for partial satisfaction of the subtask objective has yet to be evaluated.

The output of this subtask will produce much of the base map and other data required for FERC Exhibits J and K, general and detailed project maps respectively. The requirement for 10' contours is explicit under FERC regulations for Exhibit K. Should new regulations relax that rule, effort will be adjusted accordingly.

(d) Level of Effort

(i) Prior to license application:

Task Force (R&M)....................$500,000
Coordination and Review (Acres)......$ 25,000

Total Subtask 2.08..................$525,000

(ii) Subsequent to license application....$598,000

(e) Schedule

Weeks 3 through 39

Subtask 2.09 - Control Network Surveys

(a) Objective

Provide a more frequent interval of horizontal and vertical survey control than currently exists in the project area.

(b) Approach

Both U.S.C. & G.S. and recently conducted private control network schemes will be expanded for use on site specific surveys, photo control surveys and cadastral surveys of otherwise protracted township and section surveys. The control network will also be used to expand State Plane and Universal Transverse Mercator grid values to all project surveys.

The frequency of high order survey monuments of known precise horizontal values are all but non-existent in the project area.

Utilizing "one second" theodolites, medium to long range electronic distance measuring devices and helicopter supported ground crews, a chain of high accuracy control monuments will be established on each side of the river basin from the upper reaches of Watana Reservoir site to the lower end of Devil Canyon. This network will serve as the "spine" of all subsequent survey activity and mapping effort.

A precise level circuit will be run extending from the existing U.S.C. & G.S. circuit up to the Parks Highway-railroad, up river through both the Devils Canyon Dam site and the Watana Dam site and tying to the existing U.S.C. & G.S. circuit along the Denali Highway.

This level circuit will be the first precise level circuit ever run in the area and will be the basis for all vertical elevations used on the project.

(c) Discussion

It is worth pointing out that a control network survey will be required in the project area regardless of whether or not the Susitna Hydroelectric Project is ever constructed. Native land claims selections line both banks of the Susitna River and any transfers of lands under the Native Land Claims Act will necessarily be provisional subject to proper survey. We assume that this required effort will be federally funded.

(d) Level of Effort

Assumed to be undertaken by Federal Government--no costs included.

(e) Schedule

Weeks 5 through 30

Subtask 2.10 - Access Roads

(a) Objectives

Define alternative access routes; evaluate technical, economic, and environmental factors for each; and recommend best alternative.

(b) Approach

Access roads will be required during construction to dam sites, quarries and borrow pits. Effort will be made to minimize grades, number and size of borrow pits, unwanted access, and limit environmental constraints at the smallest cost and time to the project.

Geological studies and surveys are discussed under other task headings.

For this portion of the work it is anticipated that three separate routes will be considered in detail. Two of these routes will originate from the Park's Highway and extend to the east to the dam site. One route will follow the north bank of the Susitna River to the dam site. The other route will follow the south bank of the Susitna River. The third route to be considered will come from the northeast from the Denali Highway. It is further anticipated that one of these routes will be selected to be considered as a possible railroad access route. In addition, a sub-alternative to be considered in the Parks Highway routings will be one which envisions the establishment of a railhead (near Gold Creek, for example) as the western terminus of the access road.

The preliminary study portion of this phase of the work will entail reviewing photos and existing maps of the possible access routes as well as the complete review of all work already completed by the U.S. Army Corps of Engineers. Once this work is completed, it is anticipated that all three corridors selected for possible access routes will have low level aerial photography flown. Once this photography is available, detailed analyses of the photos coupled with existing data will result in initial route selection. During this process those problem areas identified by the low level aerial photography will be investigated in the field to determine solutions. Following this work cross comparisons of preliminary design will be accomplished so as to finalize selection of the best access to the project. Environmental data collection and impacts analysis of alternative routes--and, in more detail, of the selected route--will be accomplished as a part of Task 7 - Environmental Studies. Sufficient detail will be developed to permit preparation of a preliminary cost estimate. Selection of a best route will consider all aspects and will draw heavily as well on inputs from the public participation program outlined in Task 12.

Subsequent to license application, full control will be established along the access route that has been selected and once again low level aerial photos will be flown and mapping will be accomplished to a five foot interval at a scale of 1-inch = 200-feet. Once this information has been obtained, the detailed design of an alignment within the route corridor will be accomplished. In conjunction with this detailed alignment study, possible material sites will also be investigated. Once the final alignment has been established, the drilling program to establish geotechnical and geological criteria will be initiated. Upon the completion of that phase, further investigations will be necessary to remedy any problems discovered by the geotechnical information. After this phase is completed the final costing for the selected alignment with the proposed plan and profile sheets and a written report will be presented.

(c) Discussion

The selection of access roads involves consideration of diverse factors and neither technical ease of development nor economic considerations alone will necessarily be the deciding factor. Indeed, fundamental questions regarding eventual plans for controlling access to the project and the fragility of the environment itself will be extremely important. In this regard, an access road which connects only with a railhead (to be established, for example, near Gold Creek) would better facilitate controlling visitor access than would a connection with any of the highways. There is little doubt that conflicting interests will need to be addressed. It is certain that Native villages and the Cook Inlet Region, who will eventually acquire surface and subsurface rights in the project area, will have to be heeded. It is certain, too, that the impacts on local fish and game populations will have to be weighed and assessed. In short, this subtask will provide for the collection of engineering data, the preparation of preliminary economic data, the evaluation of environmental data collected on other tasks, and the selection of the apparent best choice when all factors are considered in their proper perspectives.

(d) Level of Effort

(i) Prior to Application:

Task Force (R&M)....................$150,000
Coordination, Evaluation in Light of Environmental Impacts, and Review (Acres).....................$ 35,000

Total Subtask 2.10.................$185,000

(e) Schedule

Weeks 52 through 100

Subtask 2.11 - Map and Photo Search

(a) Objective

Conduct a preliminary assessment of the reservoir areas as the basis for identifying proper locations for pursuing an optimum field reconnaissance program.

(b) Approach

All aerial photography, sattelite photography, existing topographic maps, geologic maps, and other available field information will be reviewed by selected members of the project team. This review will concentrate on the identification of particular areas which require verification or evaluation in the field during a site inspection. Based upon this review, a program for conduct of subsequent field reconnaissance efforts will be planned in detail.

(c) Discussion

Depending upon ultimately selected dam height and sites, reservoirs can be upwards to 100 miles in length. It is neither necessary nor practical in the pre-licensing phase to conduct detailed extensive investigations of every square foot in this extensive area. Even so, a proper assessment of the implications of inundation in the project area will be necessary. Based upon this assessment, cost estimates involved in preparing lands for eventual inundation can be derived. In addition, there may be ways and means to reduce environmental impact if judicious use of materials recovered from reservoir areas is planned in the project construction.

(d) Level of Effort

Task Force (R&M)...........................$4,000
Coordination and Review (Acres)............$1,000

Total Subtask 2.11.........................$5,000

(e) Schedule

Weeks 16 through 26

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Subtask 2.12 - Field Reconnaissance of Reservoir Area

(a) Objectives

Make on-the-ground checks to verify adequacy of information obtained during the map and photo search; more precisely delineate dimensions of those portions of the reservoir area which are likely to require special attention during the ultimate construction of the project.

(b) Approach

The field reconnaissance team will be furnished with marked-up maps produced during Subtask 2.11. By making on-the-ground inspections, the team will be able to ascertain the extent of clearing required as well as estimate size, nature and density of various trees to be removed. In addition, some initial estimates will be made of soil types, particularly as they would affect slope stability. To the extent that surficial inspection will reveal it, the field team will seek borrow areas in reservoirs in order to minimize eventual environmental impact outside reservoir areas.

(c) Discussion

A portion of the field reconnaissance effort can actually be accomplished by helicopter, as the reconnaissance team overflies reservoir areas and checks the general shape and location of vegetative growth to be removed, verifying that it has been accurately reflected in the initial subtask.

Some on-the-ground verifications will be required. The whole effort insofar as field reconnaissance is concerned, is primarily geared toward producing a reasonable estimate of the effort required in preparing various areas for eventual innundation. In this regard, for example, it becomes important to verify the size, nature, diameter of trees because marketability will be studied. The question of slope stability and protection is naturally pertinent since the reservoir level particularly behind Watana Dam is expected to fluctuate on an annual basis by as much as 150 feet. This latter question is separately address in Subtask 2.15.

(d) Level of Effort

Task Force (R&M)........................$5,000
Coordination and Review (Acres)..........$ 500

Total Subtask 2.12......................$5,500

(e) Schedule

Weeks 26 through 34

Subtask 2.13 - Marketability and Disposal Study for Reservoir Area

(a) Objectives

Study alternative means for disposing of vegetative material to be removed from the reservoir area.

(b) Approach

Enquiries will be made of various companies dealing in timber in Alaska with a view toward determining the extent to which timber harvested from the proposed reservoir areas may be marketable. In the event that the costs of recovery exceed market values, an assessment will be made of intangible benefits which may still suggest that attempting to sell cut timber is the appropriate option. Other alternatives for disposing of materials to be removed will be considered, to include burial as well as burning. Native villages whose lands border or actually overlap with proposed reservoir areas will be consulted during the course of the study with a view toward seeking their desires on timber disposal.

(c) Discussion

It is important to note that economics will not be the only determinant in the evaluation of alternative means for disposing of vegetative materials. Indeed, ultimate disposition may be directed far more by other factors than by apparent least cost alone. Even so, for purposes of estimating costs for licensing, it will be sufficient to represent the probable least cost method of undertaking the work. Native villages owning surface rights to the affected areas will be directly affected by this work. CIRI will coordinate the input of the villages.

Data gathered during the previous subtask regarding sizes, types and quantities of trees as well as slope conditions and general accessibility will be used. Alternatives such as helicopter logging, construction of logging roads and use of hovercraft will be considered. There is a distinct and important interface between this study and environmental studies conducted in the same area. Summary impacts will be described to indicate the most serious consequences of burial, burning, and removing. While data collection during previous subtasks will have been accomplished during the summer period, the marketability and disposal study itself can be conducted at any time thereafter.

(d) Level of Effort

Task Force (CIRI)	$ 9,800
Task Force (R&M)	$ 1,900
Task Force (Acres)	$ 4,800
Total Subtask 2.13	$16,500

(e) Schedule

Weeks 34 to 48

Subtask 2.14 - Cost Estimates for Reservoir Clearing

(a) Objective

Determine reservoir clearing costs.

(b) Approach

This subtask is not independent of the marketability study which precedes it in this Plan of Study. For each marketing alternative, there could be a different clearing approach. Thus, a series of successive iterations of cost estimates will be necessary until the proper combination of marketing approach and its related clearing technique has been found. An estimate will then be made of the costs of doing the clearing so that the net profit or loss on timber marketing can be determined.

(c) Discussion

It will be necessary during this task to separate clearing costs for reservoirs associated with each of the proposed dams. This will permit subsequent evaluations of a range of alternative phasing for separate dams in the system.

(d) Level of Effort

Task Force (Acres)........................$7,500

Total Subtask 2.14........................$7,500

(e) Schedule

Weeks 34 to 48

Subtask 2.15 - Slope Stability and Erosion Studies

(a) Objectives

Estimate the extent to which cleared slopes will maintain stability; estimate the risk that continued reservoir operation will cause one or more slopes to fail; and estimate costs of minimizing slope failure risks.

(b) Approach

Field data collected during the reconnaissance under Subtask 2.11 will be used as the basis for analyzing the potential for slope stability problems. To the extent that such problems appear to exist, alternative means of slope protection will be considered. It will be assumed that slope protection will be required if there is a danger of failure during continued operation.

(c) Discussion

Risk estimates developed during this study will be used ultimately in the risk analysis to ensure that all potential difficulties have been accounted for. The costs of providing appropriate slope protection necessarily become a part of the total project cost estimate to be considered ultimately in determining project financibility and viability.

Subsequent to submission of the license application, much more detailed and vigorous erosion control studies will be required to minimize damage caused by a concentrated flow of water over newly constructed slopes or in areas where the natural vegetative cover has been removed. The objective of this post-application task will be to issue recommendations and deliniate problem areas where an added degree of caution should be exercised. A two part study is contemplated to fulfill these needs. This task will be limited to the general site earthwork and is not intended to address erosion of the downstream channel of the dam site.

Input from the first phase of the detailed erosion study will come from an evaluation of soil types obtained from project test borings and laboratory test data. Air photo studies will also be used. It is presently anticipated that sufficient number of test borings will have been drilled in other project tasks to accomplish this study without additional test borings. Nevertheless, samples of surficial soil may be collected for identification and classification purposes, and laboratory tests may be performed.

A report describing areas of varying degrees of erosion susceptability will be prepared. Some of the factors that will be considered in this evaluation will be the soil type and its consistency. Inclusive in this report will be a discussion of erosion control for general site grading.

(d) Level of Effort

Task Force (Acres)....................$8,200

(e) Schedule

Weeks 47 to 54

Subtask 2.16 - Hydrographic Surveys

(a) Objective

Provide field and aerial survey data relating to the river gradient and cross sectional configuration of the active flood plain.

(b) Approach

Through the use of deferential level circuits, 60 miles of river will be profiled from the lower portion of Devil Canyon, downstream, to the confluence of the Susitna, Talkeetna and Chulitna Rivers near the town of Talkeetna.

Pre-set picture panels for aerial photogrammetry will be tied to the profile level circuit for later use in river cross sections.

Cross sections of the river's active flood plain will be measured at approximately one mile intervals and based on elevations established during river profiling.

The true interval and relationship of river cross sections to the river and other cross sections will be determined photogrammetrically and geometrically from pre-set picture panels (crosses) that can be identified in the aerial photos.

(c) Discussion

Careful study of downstream hydrographic conditions is a vital part of the total data collection effort, particularly because project operation will produce changes in the flow regime. Subsequent environmental studies will rely on the data produced here for use in the study of potential impacts on fisheries as well as on moose browse now growing in certain low areas subject to regular inundation when the project operates. In addition, as design studies progress, determinations will be made as to the need for re-regulation structures.

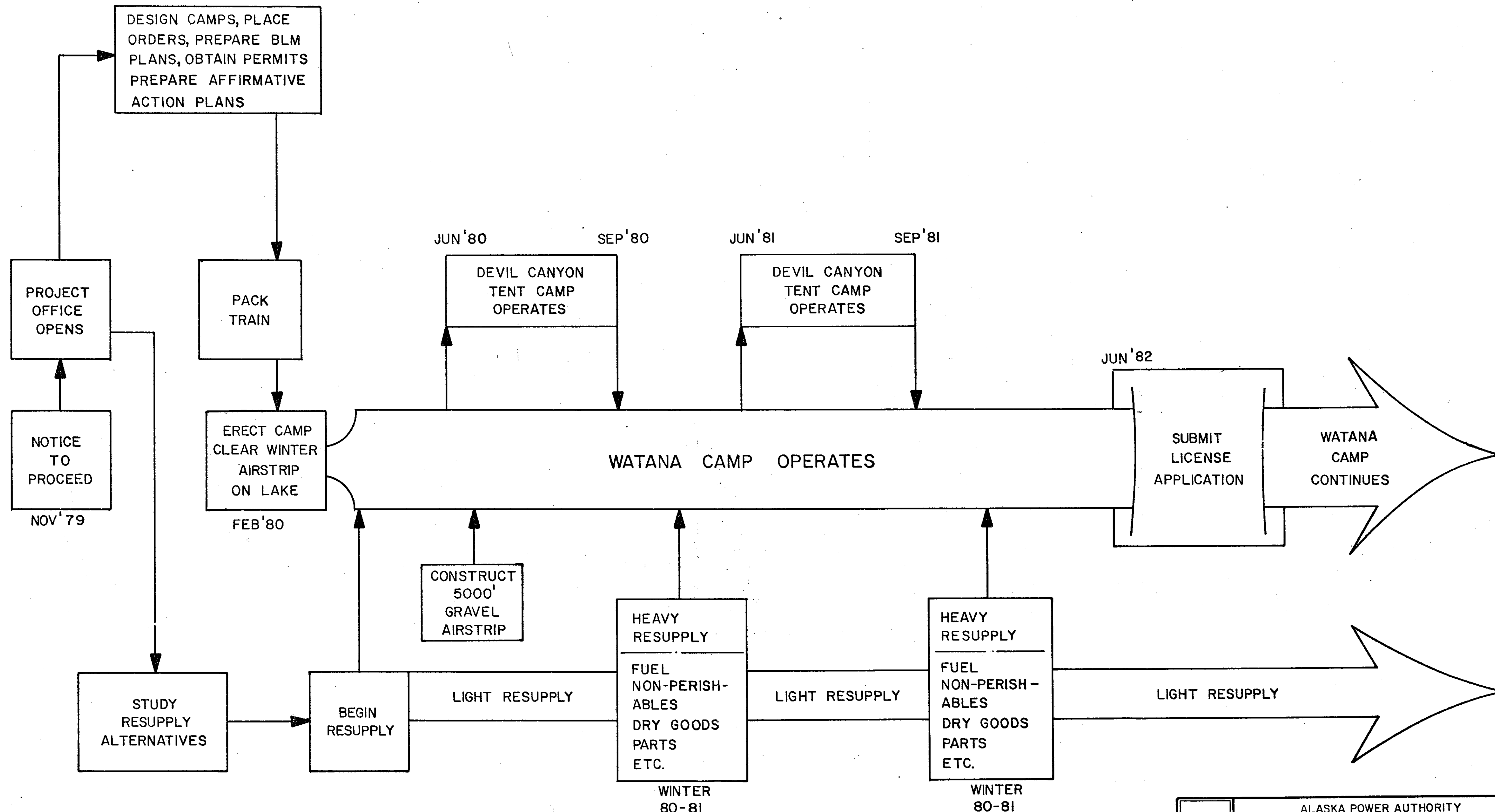
(d) Level of Effort

Task Force (R&M)..........................$245,000
Coordination and Review (Acres)...........$ 13,000

Total Subtask 2.16........................$258,000

(e) Schedule

Weeks 5 through 17 and 36 through 48



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ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

LOGIC DIAGRAM
FIELD LOGISTICAL SUPPORT

ACRES AMERICAN INCORPORATED

PROJECT: P 5477.00

PLATE T2.1

TASK 3: HYDROLOGY

A.5.4 - TASK 3: HYDROLOGY

(i) Task Objectives

To undertake and report on all hydrologic, hydraulic, ice,and climatic studies necessary to complete the feasibility design of the Susitna project and to provide sufficient documentation for the FERC license application.

(ii) Task Output

- Data Index System

  A data index system listing all the available hydrologic and climatologic data will be compiled and circulated. Hard copies of the more relevant data items will be stored in the project office in Anchorage and copies made available to those requesting it.

  All the additional hydrologic and climatologic field data collected as part of this study will be documented on either computer printout sheets or typewritten tables.

- Written Sections and Drawings for Inclusion in the FERC License Application

  Exhibit H - proposed reservoir operating rules, predicted reservoir behavior, and downstream water quality and flow conditions.

  Exhibit I - dependable power flow, critical design low flow period, flow duration curves and tailwater rating curves.

  Exhibit K - reservoir shorelines for maximum and minimum reservoir water levels and reservoir water level area and capacity curves.

  Exhibit L - spillway design flood and capacity and freeboard allowance.

- Hydrologic Appendix to Engineering Report

  The detailed technical appendix will contain sections on the following type of studies: hydrology (resource and floods), reservoir operation, hydraulic, sediment yield, river morphology, ice engineering, climatic studies for transmission line design, and hydrologic and hydraulic studies for the access road.

- A Series of Design Transmittals

  These will summarize the pertinent design parameters obtained from the studies outlined above.

(iii) List of Subtasks

3.01 - Review of Available Material
3.02 - Field Data Index and Distribution System
3.03 - Field Data Collection and Processing
3.04 - Water Resources Studies
3.05 - Flood Studies
3.06 - Hydraulic and Ice Studies
3.07 - Sediment Yield and River morphology Studies
3.08 - Climatic Studies for Transmission Line
3.09 - Access Road Studies

(iv) Subtask Scope Statements

The scheduling of the above subtasks is presented in Section A7, Plates A.7.1. The activities have been specifically scheduled to make maximum use of the field data as it becomes available and to provide the necessary input to the other components of the studies.

Arrangements have been made to enlist the services of Dr. R. Carlson to act as consultant to Subtask 3.05 (Flood Studies). We proposed to make similar arrangements wtih Dr. T.E. Osterkamp of the Geophysical Institute, University of Alaska to act on the ice engineering related aspects of Subtasks 3.06 (Hydraulic and Ice Studies) and 3.03 (Field Data Collection and Processing).

A detailed discussion of the objectives, the approaches and the costs and schedules associated with the subtasks follows.

Subtask 3.01 - Review of Available Material

(a) Task Objectives

Assembly and review of all available reports, maps and studies relating to hydrologic aspects of the Susitna and neighboring basins, and abstraction of hydrologic design parameters required for the planning studies concerned with alternative hydro sites, including small hydro development.

(b) Approach

All available reports, maps and other pertinent documents will be obtained and reviewed. Detailed discussions will be held with individuals and agencies who have been engaged in the past and who are currently engaged in studies in the Susitna basin and surrounding areas, (e.g., staff at the University of Alaska, APA, the Hydrology Section of the U.S. Corps and the USGS office staff in Anchorage).

All information on mean annual flows, seasonal distribution of flow, reservoir drawdown and firm and installed capacity will be abstracted. If necessary, manual adjustments will be made to these parameters to ensure that standardized parameters are available for each site and that similar approaches are applied to defining firm power and installed capacity.

(c) Discussion

This task will be performed jointly by R&M and Acres.

(d) Level of Effort

Task Force (Acres)	$ 4,400
Task Force (R&M)	6,100
Total Subtask 3.01	$ 10,500

(e) Schedule

Weeks 0 through 26

Subtask 3.02 - Field Data Index and Distribution System

(a) Objectives

Establish a formal data indexing and distribution system to keep the study team and all other parties concerned with the project fully updated on the status of available hydrological and climatologic data.

(b) Approach

The field data acquisition requirements for the proposed study are substantial. A data index describing all the currently available hydrologic and climatologic data will therefore be compiled. All new data collected by other organizations within the basin and by the study team will be added to the index. It is proposed to update the index every six months.

Hard copies of the available data will be obtained and stored. Copies of selected items of data will be dispatched to project team members and other concerned parties on request. All new field data collected by the project team will be stored on computer facilities and/or in tabulated form. Copies of the information will be issued to those requesting it.

(c) Discussion

It will not be possible to obtain and store hard copies of some of the detailed climatic data collected at the existing complete meteorologic stations or from the proposed automatic climate stations. However, provision will be made to access these data files and abstract from them data in summarized form as required by the project staff.

This work will be done by R&M.

(d) Level of Effort

Task Force (R&M) .... $ 75,200

(e) Schedule

Setup: Weeks 5 through 13
Operation: Weeks 14 through 130

Subtask 3.03 - Field Data Collection and Processing

(a) Objective

To supplement the available streamflow and climatologic data within the Susitna River Basin and along the proposed transmission corridors.

(b) Approach

The data collection program outlined in this section has been specifically tailored to provide adequate input to the design of the project and to meet the requirements of the FERC licensing procedure.

- Field Data Specifications

It is proposed to produce formal specifications for all the hydrologic and climatologic field data to be collected. This will facilitate the detailed planning of the field program and will allow the various technical disciplines associated with the study to derive maximum benefit from the data collection program.

During the early stages of the study, data specifications will be drawn up by a multidisciplinary team responsible for environmental, hydrologic, hydraulic and ice engineering aspects of the study during the initial field trips in the area. These specifications would be submitted to Federal and state agencies for comment to insure that maximum benefit is derived from the field program.

The specifications will describe items to be collected, list the type of equipment to be used, the accuracy to be achieved, the frequency of the observations and the rate at which the information is to be processed and published.

Discussions will be held with the consultants to the study based in the University of Alaska to explore the possibility of applying satellite or high-level aircraft photography to improve accuracy of estimating the spatial distribution of the snow cover. It should be noted that no budget has been provided for undertaking this type of work should it prove feasible.

- Field Data Collection

In order to ensure that adequate data is available for the feasibility design and license application and subsequent preliminary engineering, an early start must be made with field data collection. A tentative program has been developed and is summarized in Table A.5.1. Provisional locations of data collection points are shown in Plates T.5.1. and T.5.2.

A permanent field crew of two people will be assigned to install and operate the equipment and to retrieve the data. Extensive use will be made of helicopter transport to access the remote stations. A fixed wing aircraft will be used in the aerial ice cover surveys and to service some of the remote snow course and climatic stations.

During the first half of 1981, the field data specifications will be reviewed and amended in the light of one year's experience in the field. It is anticipated that the location of the transmission line corridor will have been finalized and that some of the automatic climatic in-cloud icing and freezing rain stations may have to be relocated. The additional three automatic climatic stations, as well as the additional in-cloud icing, freezing rain and snow creep stations will be installed.

- Field Data Processing

Field data processing will be concerned with the following:

-- abstracting and storing information on the charts obtained from the automatic climatic stations and water level recorder
-- calculating water and sediment discharges from field observations
-- laboratory analyses of water quality and sediment samples
-- documentation of the ice cover observation program
-- documentation of the snow course data, transmission licensing, freezing rain, snow creep and glacial measurements.

Some of this data processing will be carried out on a computer, the remainder will be dealt with manually.

A technician will be responsible on a full-time basis for all the data processing. Additional technical assistance will be available as and when required.

(c) Discussion

This task will be undertaken by R&M with review by Acres. Important aspects associated with Table A.5.1 are as follows:

- The program has been based on the assumption that the Devil Canyon and Watana Dam site will be the selected project sites.

- The initial location of the climatic stations is based on the assumption that the transmission route will be located along the railway linking Fairbanks and Anchorage. Should an alternative transmission corridor be selected during 1980, the climatic stations installed along the rail route will be relocated during 1981. This is not anticipated to cause any delays in the study as the data obtained during the first year could be used to obtain preliminary design criteria for the alternative route. Provision has been made in the cost estimates to cope with relocation of the stations.

- An additional five automatic climatic stations will be held in reserve during the first year. It is intended to utilize two of these as spares. The three others will be installed during 1981 along the selected transmission line to improve estimation of the spatial variation in design parameters.

- Discussions have been held with the staff responsible for the snow course surveys at the Soil Conservation Service in Anchorage. As a result the locations of the additional four snow course stations depicted in Plate A.5.2 were selected. These discussions also indicated that snow pillows have been operated very successfully and should function well at the proposed locations. Only a minimum amount of measurement using conventional snow survey equipment will be necessary.

- The proposed sediment station at the Vee site (see Plate A5.2) will not be operated on a continuous basis. A limited number of observations will be taken and used to assess whether the sediment discharges at Vee and Gold Creek are correlated. If these analyses indicate no correlation, then the sediment observations at Vee will be increased during Phase 2.

- We do not propose to use bed load samplers during this phase of the work. Although the Heli-Smith type sampler has been successfully used by the USGS on the Tanana River, it is doubtful whether it would operate in the coarse sediments of the Susitna. However, this aspect will be reviewed once more detailed information on the bed material is available. If deemed practical and useful, a bedload sampler could be employed during Phase 2 to firm up estimates of bedload.

(d) Level of Effort

Task Force (R&M)	$ 656,600
Equipment Purchase	208,000
Helicopter Transport	250,000
External Consultant	5,000
Liaison and Review (Acres)	15,000
Total Subtask 3.03	$1,134,600

(e) Schedule

Field Data Specifications and Review - Weeks 14 through 22
Weeks 70 through 74

Equipment Installation - Weeks 23 through 35
Weeks 75 through 82

Field Data Collection - Weeks 31 through 130

Field Data Processing - Weeks 36 through 130

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Subtask 3.04 - Water Resources Studies

(a) Objectives

To develop all the necessary water resource parameters such as monthly flow data, design low-flow characteristics, etc., at the reservoir sites and to study long-term reservoir operation.

(b) Approach

(i) Streamflow Extension

Multiple regression analyses will be used to develop monthly streamflow sequences at the Watana, Devil Canyon and other sites being considered with the Susitna basin. The aim is to improve on the correlations previously achieved in the U.S. Corps of Engineers studies. The gauging station at Gold Creek (2920) will be used as the master station. However, attempts will be made to see whether meaningful correlations can be achieved by using longer-term stations outside the study area (e.g., Matanuska River at Palmer 2840). Both monthly and annual flows will be correlated and climatic parameters such as monthly/annual temperature and preciptation will be introduced to determine whether they improve the correlations. Extrapolation of mean annual flow and the seasonal variation of flow to ungauged locations will be done using factors developed from drainage basin area and other physiograpic and climatic parameters (e.g., area covered by glaciers, lakes and swamps, mean annual precipitation, and mean annual temperature).

Acres will undertake these analyses.

(ii) Low-Flow Frequency: Duration Analysis

Utilizing the above information, analyses will be carried out to produce curves relating volume of runoff in low-flow periods of different durations ranging up to several years to the frequency of occurrence. These curves would be used to determine firm power and energy from the proposed developments during specified critical low flow periods.

Acres will undertake these analyses.

(iii) Reservoir Filling and Operation Studies

It is proposed to set up the Acres' multireservoir water balance computer model for the Susitna basin. This is a particularly versatile model, and allows easy application to different reservoir systems. Reservoir operation rules are specified as input data, thus allowing considerable flexibility in studying alternative rules and priorities. The model can operate with time periods varying from a week to several months, and can incorporate power generation and load stacking.

This model will be used to undertake reservoir operation and energy generation studies, and the analyses required to determine filling schedules. The basic input data to the model will be derived from the studies discussed in (i) and (ii) above.

Acres will undertake the work.

(iv) Statistical Analysis of Pre- and Post-Project Streamflow

Flow duration curves are required for the FERC license application and the determination of annual sediment yields at various locations within the basins. Seasonal and annual duration curves will be evaluated using the natural monthly streamflow data derived in (i) above and for the post-project flows simulated using output from the multi-reservoir model discussed in (iii) above.

Recorded natural daily streamflow data at a limited number of gauging stations within the basin will be utilized to describe typical flow variations within the calendar months.

Once the project layouts have been finalized, the flow duration curves described above will be redeveloped for post-project flow conditions downstream from the damsites. Based on a knowledge of the daily plant operating characteristics, the effects of discharge fluctuations within typical months will be described.

Acres will undertake the studies.

(v) Evaporation Studies

Desk studies will be undertaken to refine the estimate of net evaporative loss from the reservoir surface area. Based on available climatic and evaporation data within the Susitna basin and the vicinity regional estimates of gross evaporation from an open water surface will be made and extrapolated to the damsites. Available streamflow and precipitation data will be used (again on a regional basis) to estimate the pre-project evapotranspiration rate from the reservoir area and subtracted from the open water evaporation to yield the net effect of the reservoir. R&M will undertake these studies.

(vi) Glacial Studies

The results of field surveys for detecting glacial movement and the aerial inspections and information obtained from aerial photographs will be evaluated to determine whether the glacier was noticably moving and if there was potential for a lake dump. The USGS studies on the Black Rapids Glacier will be reviewed and general information abstracted and used to assist in this evaluation.

Should these studies indicate that changes in the glaciers water and sediment yield could occur, or that a lake dump could develop, a more comprehensive long-term glacial observation and study program would be planned for implementation during Phase 2.

R&M and Acres would jointly undertake this study.

(c) Discussion

The streamflow extension (Section (i)) analyses will be based on available streamflow data up to the end of the 1978-1979 year, i.e., October 1979. The data obtained during the first 12 months of the field program will be utilized to check on the validity of the extrapolation factors used to derive streamflow data for ungauged sites. If deemed necessary, these factors will be revised and the appropriate adjustements made to the streamflow data.

(d) Level of Effort

Task Force (Acres)	$ 97,300
Task Force (R&M)	21,300
Total Subtask 3.04	$ 118,600

(e) Schedule

Weeks 31 through 126

Subtask 3.05 - Flood Studies

(a) Objectives

To provide design flood peaks and hydrographs for design of the project and for assessing pre- and post-project flood conditions in the Susitna River reaches located down and upstream of the Watana and Devil Canyon damsites.

(b) Approach

(i) Regional Flood Peak and Volume Frequency Analysis

A localized regional flood peak and flood volume analysis will be undertaken for the Matanuska, Susitna (including the Yentna) and Chakachatna River basins, i.e., the entire Cook Inlet basin. All gauging stations with periods of records longer than 7 to 8 years and with drainage basin areas larger than approximately 250 square miles will be incorporated in the analysis.

Annual maximum and seasonal maximum flood peaks will be abstracted from the records. It is proposed to use two seasons: the season during which significant ice cover is present and the ice-free season. The flood peak data will be subjected to frequency analyses using the Log Pearson Type III distribution (or alternatively the three Parameter Lognormal distribution which has been found to work well in northern climates). These individual frequency curves will be utilized to develop regional frequency curves as well as regression equations for predicting design flood peaks at ungauged locations within specified homogeneous flood regions. The definition of homogeneous flood regions will be based both on statistical tests (e.g., Langbein) as well as visual plots of single station frequency curves.

In developing regression equations, use will be made of physiographic parameters such as drainage basin area, area covered by glaciers and lakes or swamps, mean late winter snow cover, mean spring temperatures, etc. The results obtained will be compared to those presented in the broad-based regional study recently completed by Lanke (USGS, Water Resources Investigations 78-129).

A flood volume frequency analysis will be undertaken for the streamflow records on the Susitna at Gold Creek (2920) and at Cantwell (2915). A screening process will be undertaken to determine which of the flood types are the most critical:

- spring floods
- high mountain snow melt - rainfall events (June/July)
- summer rainfall events.

The annual maximum flood volumes associated with the critical type will be abstracted from the streamflow data files and subjected to a frequency analysis. Analyses will also be undertaken to determine whether a relationship exists between the ratio of the flood peak to the flood volume and to develop typical flood hydrograph shapes. The results of these calculations will be used to develop design flood hydrographs for the proposed reservoir sites on the Susitna. Extrapolation to the ungauged sites will be accomplished by using drainage area ratios or factors involving other physiographic and climatic parameters. R&M would undertake this work and Acres would act in a review capacity.

(ii) Probable Maximum Flood Determination

The approach adopted by the U.S. Corps in their feasibility studies in developing the Probable Maximum Flood (PMF) is appropriate for this stage of the study. The SSARR watershed model used was reasonably well calibrated considering the paucity of available data. Recalibration would not be warranted until the proposed new climatic stations (Subtask 3.03) have been installed and operated for at least two years. It is therefore proposed to undertake a detailed review and revision of the input parameters to the U.S. Corps model. Several runs will then be undertaken with the model to test for sensitivity of output to changes in input data and to revise the estimate of the PMF if necessary. The key input parameters that would be reviewed include:

- probable maximum precipitation
- initial snow cover
- temperature sequence
- loss rates or loss functions.

The cost estimate below allows for rerunning the SSARR model. It is assumed that the consultants would have access to the U.S. Corps' model. Acres will undertake this work.

(iii) Reservoir Flood Routing

In-house computer programs will be used to route design floods through the proposed reservoir system. These studies will be used to size the required service and emergency spillways and would also produce the downstream post-project flood hydrographs required for the downstream water level and ice studies (Subtask 3.06). Acres will undertake this work.

(c) Discussion

During Phase 2, more extensive analyses would be undertaken to firm up the design flood estimations (see Section A.7). This would include recalibration of the SSARR model or, if deemed to be more appropriate, the application of an alternative computer model such as the more sophisticated Hydrologic Simulation Package (HSP) developed by Hydrocomp or the National Weather Service model.

(d) Level of Effort

Task Force (Acres)	$ 24,100
Task Force (R&M)	36,100
External Consultant	7,500
Total Subtask 3.05	$ 67,700

(e) Schedule

Weeks 31 through 126

Subtask 3.06 - Hydraulic and Ice Studies

(a) Objective

The determination of water levels and ice cover conditions upstream and downstream from the project sites under flood and low-flow conditions corresponding to pre- and post-project conditions.

(b) Approach

Computer model simulations will be carried out to compute the pre-project to predicted post-project conditions and to provide input to the civil layout and system operation studies. This will ensure that potential problems such as the maintenance of a stable ice cover, ice jamming and flooding, etc. can be dealt with during the project planning and design process. The results of the studies will also be utilized in the environmental studies (Task 7) to assess potential environmental impacts.

(i) River Channel Water Levels and Flows

We propose to utilize the following three basic computer programs to study the water level and ice regime in the Susitna River from just upstream of the Watana site to Talkeetna.

- HEC-2 - (Acres modified version, incorporating an ice cover)
- Ice Cover Process Model - This is a computer program which has been developed in-house by Acres specifically for hydropower generation studies in northern climates. It simulates the growth and decay of a stable ice cover on a channel containing flowing water.
- One-Dimensional Dynamic Flow Model - Acres has several in-house versions of this program which is capable of simulating the dynamic response of a channel to a time varying flow input.

All of the above models are one-dimensional flow models. Table A5.2 indicates which of the Susitna River reaches these models will be applied to and the purpose of the simulations to be carried out.

The ice cover observations and the ice cover thickness and strength measurements undertaken by the Geophysical Institute and made during the course of this study will be utilized for:

- calibrating the ice cover process model
- determining typical ice cover conditions to be simulated with the backwater program (HEC-2)
- assessing where potential ice jams could occur.

The studies outlined in Table A5.2 deal with the Susitna River only as far downstream as Talkeetna. It is proposed to use a less rigorous approach to assess the effects of proposed project on flow in the river channel downstream from Talkeetna. Should these analyses indicate that more detailed studies are required, they will be done during Phase 2.

As soon as the topographic survey information of the Susitna reaches concerned becomes available and sufficient water level observations are obtained (Subtask 3.03), the above models will be set up and calibrated. The simulation exercise will then follow and continue on through the project design studies (Task 6).

Acres and R&M will jointly undertake the above studies. R&M will concentrate on the river reach downstream from the Devil Canyon damsite, as this aspect could be usefully combined with flood plain mapping work they may be undertaking in the area. Acres will direct the work undertaken by R&M.

(ii) Reservoir Freeboard

The required reservoir freeboard for wind conditions will be evaluated. The wind data collected in the basin during the first 18 months will be utilized to extrapolate design wind conditions to the reservoir sites. Acres will undertake this work.

(iii) Slide Induced Reservoir Surge

It is proposed to undertake a literature review of previous work done in this area. Of particular interest will be the mathematical and physical modeling work done by B.C. Hydro on the Downie slide and Revelstoke dam and their work on the Mica slide. Information obtained from this review plus the results of the reservoir seismic studies (Task 4) will be used to assess the nature and magnitude of the potential problems and to establish some preliminary design criteria. Should further detailed study be necessary, a suitable methodology and scope of work would be developed for application in Phase 2. Acres will undertake this work.

(iv) Reservoir Temperature Regime

An in-house computer model will be utilized to simulate the vertical temperature stratification within the proposed reservoirs for a typical year. This model will be calibrated based on our past experience with such models, other studies on similar projects, and utilizing the results of similar work being conducted at the University of Alaska.

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Output from this model will be utilized to assist in the selection of the levels of the offtakes for the discharge structures and to predict changes in the downstream water temperatures. Acres will undertake the work.

(d) Discussion

The above approach, particularly the application of the backwater program incorporating an ice cover and the ice cover process model, has been developed based on our extensive experience with design of hydroelectric facilities in northern climates, particularly on the Nelson River in Manitoba. The type of problems we would anticipate with ice in the Susitna project and the methods that could be adopted to deal with them are discussed in Section A.2.

(e) Level of Effort

Task Force (Acres)	$ 56,300
Task Force (R&M)	43,600
External Consultant	5,000
Total Task 3.06	$ 104,900

(f) Schedule

Weeks 40 through 126

Subtask 3.07 - Sediment Yield and River Morphology Studies

(a) Objective

Determination of the rate of sediment accumulation in the proposed reservoirs and prediction of the effects on the downstream river channel morphology.

(b) Approach

(i) Sediment Yield and Deposition

The U.S. Corps of Engineers total sediment yield studies described in the 1975 feasibility report will be updated by incorporating all new data on sediment discharge that have since become available. A literature review will be undertaken to firm up the reservoir trap efficiency figures used and to develop an appreciation of the spatial distribution of the deposited sediment in the reservoir. State-of-the-art settlement theory will be used to determine average sediment concentration in the reservoir at various times of the year. This latter information will be required to determine the quality of the water released from the reservoir.

(ii) River Morphology

A thorough review of previous work done in the Susitna Basin and other Alaskan rivers and available field data for the Susitna River will be undertaken. An air photo mosaic will be prepared for the reach between Devil Canyon and Talkeetna. Historical photographs will be studied to assess past regime changes both in the main river channel and the tributaries.

Studies will be undertaken to determine a suitable regime-type equation. With the aid of this formula and input from the reservoir simulation studies (Subtasks 3.04 and 3.05) expected morphologic changes will be assessed. The more pronounced changes will be illustrated on the air photo mosaic.

Based on available information, changes to the morphology of the river downstream from Talkeetna will be generally assessed. Should this preliminary analysis indicate a more detailed study is required, this would be done during Phase 2.

(c) Discussion

The reservoir sediment calculations will be revised during Phase 2, once several seasons of additional field data have become available.

The state of the art in modelling the distribution of deposited sediment is not yet sufficiently advanced to produce reliable estimates of the spatial distribution of sediment within a reservoir, unless extensive calibration studies are undertaken and a large amount of field data is available. During Phase 2 of the study an assessment will be made as to the adequacy of the available data to calibrate such a model and a decision will be made whether to undertake such modelling work.

R&M will undertake the work described in this subtask and Acres will act in a review function.

(d) Level of Effort

Task Force (R&M)	$ 43,700
Liaison & Review (Acres)	2,000
Total Subtask 3.07	$ 45,700

(e) Schedule

Weeks 53 through 126

Subtask 3.08 - Climatic Studies for Transmission Line

(a) Objective

To provide climatologic design criteria for the design of transmission lines. These include ice cover thickness and wind speed.

(b) Approach

Preliminary design criteria will be evaluated during the early stages of the study. Utilizing available climatic information and experience obtained in other northern transmission line projects, design parameters will be established, i.e.,

- wind speeds
- icing conditions (frequency and thickness of accumulation)
- temperature conditions

Input will be obtained from an experienced meteorologist on staff to assist in developing these parameters. An attempt will also be made to develop a general perception of the spatial variation in these parameters for input to the transmission line route selection studies.

During the second year of the study, as the climatic field data becomes available, a more detailed approach will be adopted to firm up the design criteria. An in-cloud icing model is available in the Acres computer library and has been used to calculate ice loads for the design of a transmission line from Ocean Falls to Kemano in northern British Columbia.

We will use this model to predict ice cover thickness for specified design climatic conditions. A check on model accuracies will be made by comparing model results with measured ice accumulations from the Field Data Collection Program (Subtask 3.03) and using data from other sources such as the in-cloud ice accumulation data which is available (4 years, 42 events) for McLean Mountain, British Columbia. Determination of freezing rain accumulation will be based on the data collected in the field and obtained from other sources such as the firstorder meteorological stations in Alaska, the Yukon and northern British Columbia.

Acres will undertake this subtask.

(c) Discussion

To estimate risks of combined wind and ice loads for various return periods, two meteorological events must be considered. On the portions of routes which would carry the line to high elevations, in-cloud ice accumulation is likely to represent the most severe condition. On the portion of routes where the line would follow valley floors, freezing rain or drizzle would result in maximum loads. In-cloud icing produces rime accumulation having a density of about 0.6 g/cm^3, as does the occurrence of freezing drizzle. Freezing rain results in glaze icing with a density of about 0.9 g/cm3.

(d) Level of Effort

Task Force (Acres) .... $ 14,000

(e) Schedule

Preliminary Design Parameters - Weeks 14 through 126
Detailed Studies - Weeks 70 through 82

Subtask 3.09 - Access Road Studies

(a) Objective

To provide the necessary design flood peaks and to evaluate the capacity of the required hydraulic structures such as bridges and culverts.

(b) Approach

For design floods associated with larger basins, the results of the regional flood studies (Subtask 3.05) will be used. For the smaller catchments measured flood flows from small catchments will be utilized to develop regional flood peak relationships. Summer rainfall statistics will be evaluated and utilized with a rational type formula to calculate design summer flood peaks.

(c) Discussion

Hydraulic calculations, using standard techniques and design curves will be employed to evaluate the necessary size of the hydraulic structures. Bridge size and abutment shapes and alignments will be determined so as to minimize the effect on the drainage of water and general and local scour.

R&M would perform this subtask.

(d) Level of Effort

Task Force (R&M) .... $ 14,300

(e) Schedule

Weeks 52 through 100

TABLE A5.1 - PROPOSED HYDROLOGIC FIELD DATA COLLECTION PROGRAM

Station Type	Measured Parameters: Parameter	Measured Parameters: Type of Equipment	Time Between Observations	Time Between Station Visits	Number of Stations Installed: 1980	Number of Stations Installed: 1981	Type (and Quantity) of Major Equipment to be Purchased
Gaging	Water level	Chart or tape recorder	Continuous	Summer: 2-4 weeks	3 (2 new at project sites, reactivate USGS Station 2915 on the Susitna River)	None	Water level recorders (3 + 1 spare) Current meters (2) Boats (2) Cable ways (2) Ice augers (2)
	Water discharge	Cable way or boat and current meter	Summer: 2-4 weeks Winter: 2-3 months	Winter: 1 month			
Water level	Water level	Staff gauge and peak level indicator	Summer: 2-8 weeks Winter: 2 months	As in previous column	8	None	Staff gauges Peak level indicators
Sediment discharge	Suspended sediment concentration Bed material size	Suspended sediment sampler	As for water discharge	As in previous column	4 (3 involve supplementary measurements at USGS stations 2910, 2912, 2920).	None	Suspended sediment samplers (3) Bed material samplers (2)
Snow course	Snow pack depth and water equivalent	Conventional snow survey equipment and/or snow pillows	2-4 weeks during winter months	As in previous column	4	None	Conventional snow survey equipment (1 set). (4 + 1 spare)
Water quality	Temperature, turbidity, conductivity, dissolved oxygen, pH	Field measuring equipment	Summer: 1 month Winter: 2-3 months	Summer: 1 month Winter: 2-3 months	3	1	Meters (1 set)
	Alkalinity CO_2	Grab samples and laboratory analysis in field camp	As above	As above			Titration kit
	Total and ortho phosphorus Total and kjeldahl nitrogen Total dissolved and suspended solids Trace metals	Grab samples and laboratory analysis in Anchorage	As above	As above			Freezing equipment in field camp (1)
Climatic (automatic)	Wind speed and direction Relative humidity Temperature Rain/snow (unheated gauge)	Automatic weather station	Continuous	Monthly	6		Automatic weather stations (9 + 2 spare)

ACRES

TABLE A5.1 - PROPOSED HYDROLOGIC FIELD DATA COLLECTION PROGRAM (Cont'd)

Station Type	Measured Parameters: Parameter	Measured Parameters: Type of Equipment	Time Between Observations	Time Between Station Visits	Number of Stations Installed: 1980	Number of Stations Installed: 1981	Type (and Quantity) of Major Equipment to be Purchased
Climatic[1] (automatic with heated gauge plus some observer information)	As above, plus solar radiation Evaporation pan Visibility (heated gauge)	Automatic weather station plus some observer information	Continuous	Daily	1	None	
In cloud icing	Ice buildup on a transmission line	Short section of transmission line, 6 feet long mounted 5 feet above ground	Only during or immediately after icing conditions	Sporadic	3	2	Short section of transmission line
Freezing rain	Ice buildup during a precipitation event	Horizontal steel plate,	Only during or immediately after freezing rain	Sporadic	3	2	Steel plates
Snow creep	Snow creep	Snow markers and survey equipment	2-4 weeks during winter months	Monthly during winter months	3	5	Snow markers
Ice cover[2] (Ground survey)	Ice thickness	2-5 auger holes for measurement	Summer: none Winter: 1 month	Summer: none Winter: 1 month	8-12	0-4	Ice penetrometer
	Ice competence	Visual inspection and/or penetrometer device					
Ice cover[3] (Aerial survey)	Extent of ice cover	Visual and photographic records	During break-up period - one to several days	—	—	—	Camera equipment
	Location of ice jams		During freeze-up period - weekly	—	—	—	—
Glacial	Ice surging/ recession & glacial surface features	Survey, visual & photographic records	Two months	Two months	—	—	Survey markers

Footnotes:

(1) Located at the permanent Watana field camp.

(2) Locations to be firmed up after initial field trips and review of field data collected by Geophysical Institute, University of Alaska. Anticipate 6-8 stations on the Susitna River and 2-4 on important tributaries.

(3) As for Note 2. Anticipate to cover entire reach from Maclaren - Susitna River junction to confluence of Chulitna River.

(4) It is assumed that the existing cable at Vee can be upgraded for use.

(5) It is porposed to undertake only sporadic units to the station at VEE (i.e. at gage 2915).

TABLE A5.2

PROPOSED APPLICATION OF
ONE-DIMENSIONAL FLOW MODELS
TO THE SUSITNA RIVER

Study No.	River Reach	Model	Purpose of Simulations
1	Upstream of Watana	HEC-2, Ice Cover Process Model	To study the establishment of the stable ice cover on the Watana Reservoir
2	Watana Dam site to Talkeetna	HEC-2, Ice Cover Process Model	To study the ice cover and water level regime downstream of Watana prior to construction of Devil Canyon Dam and to calculate tailwater rating curves
3	Watana Dam Site to Devil Canyon site	HEC-2, Ice Cover Process Model	To study the ice cover regime at the Devil Canyon Reservoir
4	Devil Canyon site to Talkeetna	HEC-2, Ice Cover Process Model, Dynamic Flow Model	To study the ice cover and water level regime in the reach below Devil Canyon and to calculate tailwater rating curves
5	Watana and Devil Canyon site during the diversion stage of construction	HEC-2, Ice Cover Model Process	To design an adequate diversion system

NOTES:

The word "regime" implies the following:

- ice cover - nature and timing of growth
  - stability
  - decay and jamming
- water level - low flow conditions
  - flood flow conditions

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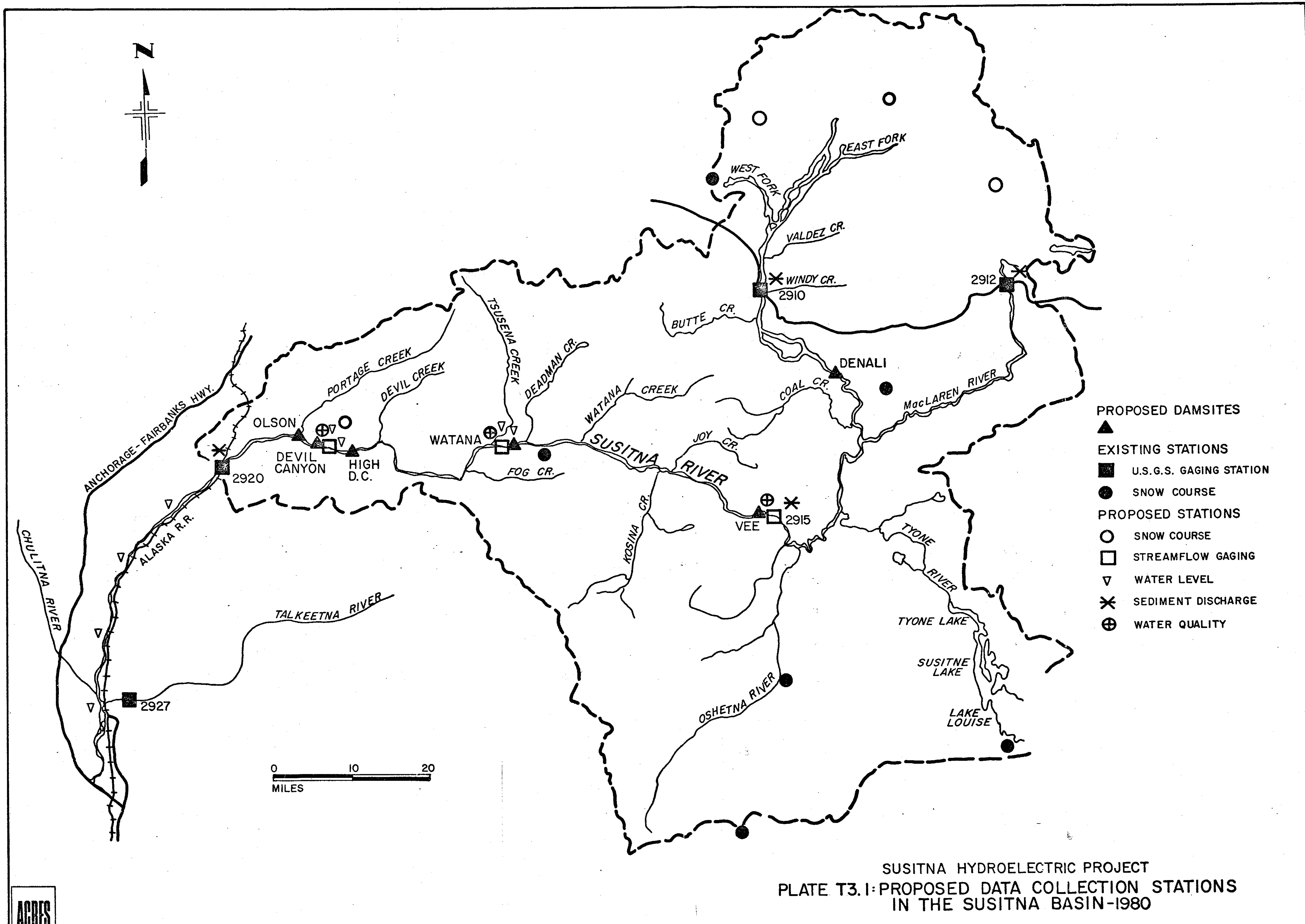
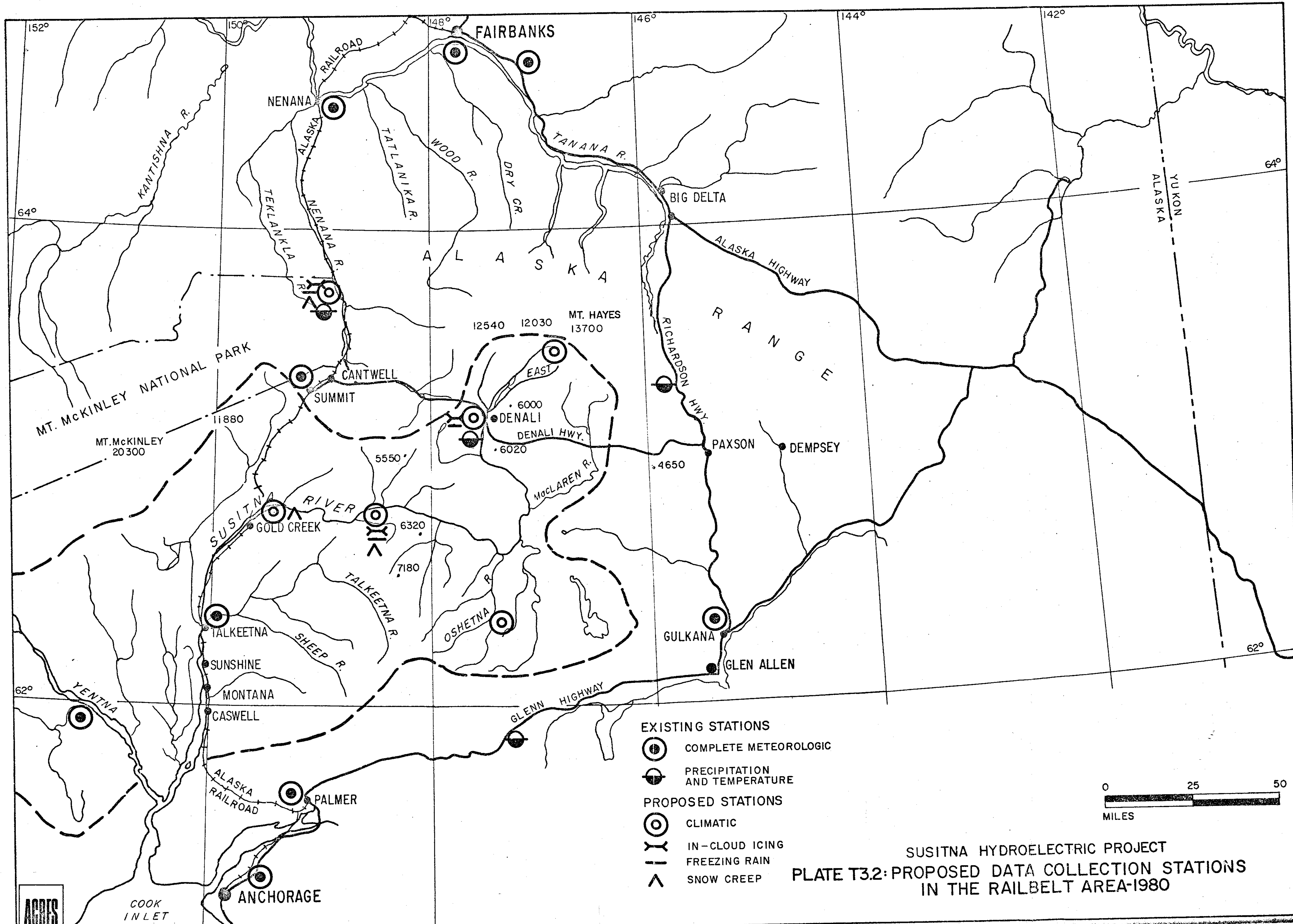


SUSITNA HYDROELECTRIC PROJECT

PLATE T3.1: PROPOSED DATA COLLECTION STATIONS IN THE SUSITNA BASIN-1980



SUSITNA HYDROELECTRIC PROJECT

PLATE T3.2: PROPOSED DATA COLLECTION STATIONS IN THE RAILBELT AREA-1980

TASK 4: SEISMIC STUDIES

A.5.2. - TASK 4: SEISMIC STUDIES

(i) Task Objectives

To determine the earthquake ground motions which will provide the seismic design criteria for the major structures associated with the Susitna Hydroelectric Project, to undertake preliminary evaluations of the seismic stability of proposed earth-rockfill and concrete dams, to assess the potential for reservoir induced seismicity and landslides, and to identify soils which are susceptible to seismically-induced failure along the proposed transmission line and access road routes.

(ii) Task Output

The data collection programs and studies outlined in this task will be sufficiently comprehensive for FERC license applications.

Thorough presentations of conclusions, evaluations and data are also desirable for projects that are being carefully reviewed by permitting agencies. Woodward-Clyde Consultants has completed previous similar projects in Alaska and other states where permitting agencies, or other interested groups or agencies, are closely scrutinizing a project. Based upon our past experience, we believe that the Susitna Hydropower Project will undergo close scrutiny, and that the reports of the project should be complete and thorough. We propose to complete the reporting of the seismic geology and seismology investigations with this philosophy as a guide.

The primary products of this task will include:

- Technical reports containing thorough documentation of all work done during the first year.

- Final technical reports containing thorough documentation for all studies during the first two years.

- Monthly management reports during the course of the investigation.

The technical reports will be accompanied by geologic maps showing locations of all controlling features, fault lines, etc.

Management reports will deal with technical and financial progress with respect to plan.

(iii) List of Subtasks

Subtask 4.01 - Review of Available Data
Subtask 4.02 - Short-term Seismologic Monitoring Program
Subtask 4.03 - Preliminary Reservoir Induced Seismicity
Subtask 4.04 - Remote Sensing Image Analysis
Subtask 4.05 - Seismic Geology Reconnaissance
Subtask 4.06 - Evaluation and Reporting
Subtask 4.07 - Preliminary Ground Motion Studies
Subtask 4.08 - Preliminary Analysis of Dam Stability
Subtask 4.09 - Long-term Seismologic Monitoring Program
Subtask 4.10 - Reservoir Induced Seismicity
Subtask 4.11 - Seismic Geology Field Studies
Subtask 4.12 - Evaluation and Reporting
Subtask 4.13 - Ground Motion Studies
Subtask 4.14 - Dam Stability Consulting Services
Subtask 4.15 - Soil Susceptibility to Seismically-Induced Failure

(iv) Subtask Scope Statements

Task 4 activities will be crucial in establishing the safety of dams and other structures under potential earthquake or induced seismicity conditions. The FERC license application for the selected Susitna project components must demonstrate convincingly that the maximum credible earthquake has been identified and the major structures have been properly designed to safely cope with such conditions.

Task 4 activites will consequently be initiated immediately at commencement of studies and will be designed to provide an effective basis for design of dams and other structures prior to submission of the FERC license application.

Task 4 activities have been subdivided into a total of fifteen packages arranged to include a program of field and office studies and installation of a monitoring system adequate to satisfy the most stringent requirements of dam safety. These activities will be appropriately coordinated with parallel geotechnical exploration and dam design efforts.

Subtask 4.01 - Review of Available Data

(a) Objective

Acquire, compile and review existing data and identify the earthquake setting of the Susitna River area.

(b) Approach

Data obtained under this subtask will be used to plan the details of the seismologic investigations (Subtasks 4.02, 4.03, 4.09 and 4.10) and the seismic geology field reconnaissance (Subtask 4.05). Available geological, seismological, and geophysical data for the region will be gathered from sources such as Woodward-Clyde files, the Department of Geologic and the Geophysical Institute of the University of Alaska, the Alaska Geological Survey, the U.S. Geological Survey, the major colleges and universities involved in research pertinent to the project. In addition, researchers with on-going programs of study will be contacted and the current status of their research will be obtained by discussions and written correspondence.

The acquisition of geological data will be concentrated on structural features of the earth that may represent major active faults. The geomorphic expressions of these features will also be identified from the available data.

Geophysical data regarding the structure of the earth will be acquired and reviewed. Regional gravity and magnetic data are particularly useful in identifying major discontinuities in the crust of the earth. These discontinuities may be along faults that could produce large earthquakes and surface fault ruptures. If available, other types of geophysical data such as seismic refraction, seismic reflection and electrical resistivity may also be of use in identifying major active faults.

Seismological data will be acquired for the project area. This data includes historical information on past earthquakes, instrumental data from the Geophysical Institute of the University of Alaska, and regional instrumental data from the U.S. Geological Survey.

The geological, seismological, and geophysical data will be compiled in order to obtain a thorough current knowledge of the tectonics of the Susitna River area. The end product will consist of maps that identify faults, lineaments, and epicenter clusters or alignments identified by others. These maps will provide a basis for the proposed geological and seismological studies.

In addition to the data acquired for the project area, data relating to reservoir-induced seismicity will also be compiled. The worldwide data on reservoir-induced seismicity will provide a partial basis for evaluating whether or not induced earthquakes may be generated in the Susitna River area. Woodward-Clyde Consultants has an extensive file on world-wide data on reservoir-induced earthquakes, and is currently being retained for further research in reservoir-induced seismicity by the U.S. Geological Survey.

The specific products of this subtask include:

- Historical earthquake map and catalog

  A catalog of reported earthquakes with magnitude 4.0 and larger from 1899 to the present will be prepared for the region within 200 miles of the site. For the larger earthquakes in the period, the geologic and engineering effects will be discussed. Data quality as a function of time will be evaluated to estimate completeness level of the catalog with respect to magnitude, focal depth, and spatial location.

- Summary of recent regional monitoring

  Microearthquake monitoring by the University of Alaska Geophysical Institute and the U.S. Geological Survey will be reviewed and summary plots of seismicity data will be prepared. Results and interpretations based on these data will be reviewed with appropriate personnel in governmental and academic organizations. Of particular importance is evaluation of the accuracy of focal depth determinations based on these network studies.

- Tectonic model

  Based on available seismologic and geologic data, a preliminary kinematic tectonic model will be developed for the region within about 200 miles of the site. This model will be modified as needed by studies in later subtasks and provides the basis for understanding the interrelated geologic source areas for future earthquake activity in the Alaskan interior. Applications and implications of seismic gap theory will be considered.

(c) Discussion

The seismicity and seismic sources of the Alaskan interior have only recently begun to be studied in significant detail. Interest in the seismicity of continental Alaska was stimulated by the occurrence of the major 1964 earthquake and involved the initiation of regional microearthquake monitoring and the augmentation of geological investigations to improve understanding of the tectonics of Alaska.

The seismological environment of the Susitna Project is characterized by two major earthquake sources:

- shallow earthquake activity occurring along crustal faults such as the Denali fault, with depth of focus less than approximately 12 miles; and

- earthquake activity in a Benioff zone which has a depth range of 30 to 90 miles and is associated with the subduction of the Pacific plate beneath Alaska.

Geological studies are used, along with seismological data, to investigate the shallow earthquake sources. The deeper-focus earthquake sources are not directly expressed at the earth's surface and must be investigated using seismological data combined with a kinematic understanding of the present-day tectonic activity of the Alaskan interior. The occurrence of past large earthquakes within the region, such as the 1904 and 1912 magnitude 7 to 8 earthquakes, indicates that both the shallow and deeper seismic zones may have the potential for generating earthquakes with ground motions significant to the project.

The Susitna River area is within a zone of active seismicity that extends from the Aleutian trough on the south into central and northern interior Alaska. Woodward-Clyde Consultants has previously conducted regional studies of seismic geology and seismicity over broad regions of Alaska. The past regional evaluations have been for the Trans-Alaska Pipeline System, the proposed Offshore Continental Shelf regions surrounding Alaska, and for the proposed Alcan Gas Pipeline. These past regional studies provide data regarding the earthquake sources in Alaska, and they also provide up-to-date knowledge of the current status of research in the area.

(d) Levels of Effort

Task Force (WCC)	$57,000
Liaison and Review (Acres)	1,000
Total Subtask 4.01	$58,000

(e) Schedule

Weeks 0 through 22

Subtask 4.02 - Short-term Seismologic Monitoring Program

(a) Objective

Establish initial monitoring system, obtain and analyze basic seismologic data on potential earthquake sources within the Susitna River area and supply information required to implement a more thorough long-term monitoring program (Subtask 4.09).

(b) Approach

This subtask involves two major packages of work:

(1) Analysis of Existing Data

Further limited analysis of existing regional earthquake data will be undertaken to enable sufficiently accurate and appropriate selection of maximum earthquake sources and associated attenuation relationships. Source studies will be carried out on several of the largest historical earthquakes, including the 1904 and 1912 events, in order to constrain their location, local depth and causative geological structure. The maximum earthquake potential of the subduction zone beneath the Susitna site is poorly understood, and it will be of significant value to use the historical data to properly characterize this source. These studies will also be directed to the evaluation of the seismic attenuation characteristics of deeper earthquakes to enable the proper utilization of the results of the Alaskan OASES study by Woodward-Clyde Consultants (1978) and other studies in selecting appropriate attentuation relationships required for Subtask 4.07 and 4.13.

(2) Establishment of a Monitoring Network

Since the study area is in a remote but seismically active area additional detailed earthquake source data will be collected by installing and operating a localized microearthquake recording network.

The network will be established and operated during the summer of 1980. The area covered will include the region within approximately 30 miles of the dam sites. Eight to ten recorders with station spacing of 5 to 10 miles will be installed to record microearth activity down to magnitude of 1.0 or less. Low-power radio telemetery will be used to make the field operation as efficient as possible. Helicopter support will be used for installation and maintenance.

Initial station deployment will be guided by the information obtained during the data review (Subtask 4.01). It will be required to monitor known significant geologic features, such as the Susitna fault.

During the course of the study, some of the stations may be moved to study specific areas of activity. Data analysis will be carried out to locate active seismic sources and evaluate their spatial extent and focal depth. These analyses will also be used to establish causative stress orientations based on focal mechanism studies, to evaluate seismic attentuation, and to evaluate the statistical features of the microearthquake activity.

Specific results to be obtained relative to source and wave propagation assessment include the association of larger earthquakes (such as the 1904 and 1912 events) with probable source structures, determination of depth of the Benioff Zone of deeper seismic activity, and attenuation characteristics of subduction zone earthquakes. Seismic source location in terms of maximum earthquake potential in the Benioff Zone will be performed. Comparisons will be made with seismic activity in other comparable tectonic areas to assess attenuation and maximum earthquake potential. The scope of these studies will be modified as necessary on the basis of the results obtained as the work progresses.

Liaison will be maintained with data collection by the University of Alaska Geophysical Institute and the U.S. Geological Survey. The recording period is initially planned as three months; however, if this should need to be modified, appropriate recommendations will be made during the course of the study.

(c) Discussion

The present location and focal mechanism level using the Geophysical Institute network is about magnitude 2-1/2 or larger. The data obtained from the proposed monitoring program will supplement the existing regional network operations and will provide needed accuracy and detection threshold. In addition, the results obtained will provide the information needed to accurately site the long-term network stations (Subtask 4.09) and to select appropriate instrumentation. They will also aid in planning the seismic geology reconnaissance (Subtask 4.05).

(d) Level of Effort

Task Force (WCC)	$253,000
Liaison and Review (Acres)	4,000
Total Subtask 4.02	$257,000

(e) Schedule

Weeks 21 through 52

Subtask 4.03 - Preliminary Reservoir Induced Seismicity

(a) Objective

Evaluate the potential for the possible future occurrence of reservoir-induced seismicity (RIS) in the Susitna Project area.

(b) Approach

The results of this evaluation will be used to establish scenarios of possible outcomes of the occurrence of reservoir induced seismicity. Woodward-Clyde Consultants has recently completed a major analysis of geologic, seismologic, and hydrologic factors associated with past cases of reservoir induced seismicity. The results of this study will also be applied to the known factors for the Susitna project in order to statistically relate the Susitna Project to the potential for RIS. The resulting potential will be evaluated in terms of possible scenarios for the occurrence of induced activity and the possible outcome of such occurrences will be discussed.

This analysis will result in a quantitative assessment of the potential for the occurrence of reservoir induced seismicity as a result of the damming of the Susitna River. A comparison will be made of depth, volume, regional stress, geologic setting, and faulting at the Susitna dam sites with the same parameters for the world's deep and/ or very large reservoirs. Based on this comparison, the probability of reservoir induced seismicity at the Susitna dam sites will be assessed.

A description of known cases of RIS emphasizing the relationship between filling of the reservoir and the length of time to the first and largest earthquakes, the relevance of these data to the Susitna dam sites will be discussed.

Scenarios will be presented that discuss possible courses of action that can be taken if RIS is anticipated or detected during filling of the reservoir.

(c) Discussion

The activities associated with this task will be closely coordinated with the hydraulic studies aimed at assessing the potential impact on the reservoir water level of a reservoir induced slide. (See Subtask 3.06).

(d) Level of Effort

Task Force (WCC)	$17,000
Liaison and Review (Acres)	1,000
Total Subtask 4.03	$18,000

(e) Schedule

Weeks 23 through 50

Subtask 4.04 - Remote Sensing Image Analysis

(a) Objective

Select and interpret available remote sensing imagery to identify topographic features that may be associated with active faulting.

(b) Approach

Data obtained under this subtask will be used during the Seismic Geology Reconnaissance (Subtask 4.05) and the Seismic Geology Field Studies (Subtask 4.11) to identify youthful faults that may produce future earthquakes and future surface fault ruptures. Remote sensing imagery and aerial photography relevant to approximately 100 km radius about the dam site will be selected for a lineament analysis. This remote sensing data includes available Landsat, SLAR (side-landing airborn radar), Skylab photography; high altitude U-2, or RB-57 color infrared photographs, and black-and-white aerial photographs. The remote sensing and high altitude imagery and aerial photographs will be interpreted in terms of the geology, geomorphology and structure of the study region.

Interpretation will help to identify lineaments and other features that may be related to active faults. Seismicity clusters and alignments identified during the seismicity evaluation in Subtask 4.02 will be compared with the lineaments identified by the imagery interpretation and the known faults on existing maps to assess the possible relationship of the epicentral locations, surficial lineaments, and mapped faults. The imagery interpretation will be conducted by geologists experienced in lineament evaluation and in the recognition of features associated with active faults. It will be important to distinguish these lineaments from similar features that result from non-tectonic geologic processes.

(c) Discussion

The activities in this task will be closely coordinated with the photo interpretation studies being conducted for the dam site, reservoir and constructed material areas (Subtask 5.02) to insure that information requests and analysis are not duplicated. Following an initial aerial and ground reconnaissance it may be decided that low-sun-angle aerial photography should be acquired for specific geomorphic features that may be fault-related. For this purpose, low-sun-angle color infrared and black-and-white photography at a scale of approximately 1:24,000 is proposed. This has proven exceedingly valuable in delineating subtle topographic features that may be fault-related. The long shadows cast by the low-sun-angle highlight subtle topographic features related to faults, such as scarps or offsets, that would be undetectable with conventional vertical aerial photographs.

Color infrared photography has also proven extremely useful in delineating subtle features in the terrain such as a contrast in vegetation or in surface moisture. Such features are often associated with faults where ground water is either closest along the fault zone or on only one side of the fault.

A map of lineaments within 100 km of the project area will be produced as a guide for Subtasks 4.05 and 4.11. The lineament map will be supplemented by mapped faults from Subtask 4.01, in order to compare known faults with lineaments of various origins.

(d) Level of Effort

Task Force (WCC)	\$52,000
Liaison and Review (Acres)	1,000
Total Subtask 4.04	\$53,000

(e) Schedule

Aerial photographs will be ordered during the first month. The analysis will be performed during weeks 10 through 26.

Subtask 4.05 - Seismic Geology Reconnaissance

(a) Objective

Perform a reconnaissance investigation of known faults in the Susitna River area, and of lineaments that may be faults, identify active faults and establish priorities for more detailed field investigations.

(b) Approach

This task will utilize the data obtained from Subtask 4.01 and the aerial photographic interpretations outlined in Subtask 4.04 as a basis for planning aerial and ground reconnaissance.

The aerial reconnaissance will systematically cover all lineaments and faults identified in previous subtasks. A field analysis will be made in order to identify whether or not each feature may be an active fault that may impact the project area due to its being associated with a large earthquake or capable of producing a future surface fault rupture. Features within 60 miles of the project area will be studied during the reconnaissance, with each lineament and fault being identified by number. In addition, regional reconnaissance of major features such as the Denali fault and the Castle Mountain fault which may extend as far as 200 miles from the project area will be investigated. Interpretations regarding the origin of each feature will be made by expert seismic geologists with past experience on similar projects. Those features that are interpreted to originate from youthful faulting, or features of unknown origin that may be due to youthful faulting, will be studied further in the field and subjected to reconnaissance-level geologic mapping.

The reconnaissance-level geologic mapping will be oriented toward identifying whether or not the bedrock units near the feature suggest the presence or absence of a fault. In addition, the Quaternary geomorphic surfaces and stratigraphic units in proximity to each feature will be studied to aid in identifying whether or not faulting has occurred in young units. The reconnaissance-level mapping, at a scale of 1:63,360, will aid in identifying those features that will require detailed study during the field season of 1981.

These activities will be coordinated with the geologic mapping tasks associated in Subtask 5.04.

(c) Discussion

The Susitna River area is in a complex tectonic area that is poorly known geologically. Previous work by Kachadoorian and Moore emphasized the structural complexity of this area, and the large number of linear features at the surface that may be due to faulting or to other origins. These surface features require field investigation to identify their origins. In order to identify the origins of some features it may require detailed mapping, trending, borings, or geophysical data. Despite thorough investigations, however, it may not be possible to obtain definitive information regarding the origins of all the lineaments.

Woodward-Clyde Consultants has conducted seismic geology reconnaissance investigations over large regions of Alaska and in many other seismically active areas of the world. Based upon that experience, we estimate that reconnaissance-level investigations as proposed in this subtask will definitively identify the origins of about 90% of the lineaments identified on remote sensing images. If these features are considered to be controlling faults for the design of dams and other important facilities, further detailed investigations will be undertaken in the Seismic Geology Field Studies, Subtask 4.11

The products of this subtask will consist of a map that identifies recently active faults, and features of unknown origins that may be faults significant to one or more dam sites and other critical facilities. In addition, all field observations will be tabulated for each lineament studied, and preliminary estimates of the maximum credible earthquake and faulting, along with the recurrences of faulting, will be made for each active fault and other features that may be faults.

(d) Level of Effort

Task Force (WCC)	$120,000
Liaison and Review (Acres)	3,000
Total Subtask 4.05	$123,000

(e) Schedule

Weeks 24 through 39

This task can begin after Subtask 4.04 is complete. Subtask 4.02 should proceed concurrently with this subtask, or it should preceed this subtask.

Subtask 4.06 - Evaluation and Reporting

(a) Objectives

Complete a preliminary evaluation of the seismic environment of the project, define the earthquake source parameters required for earthquake engineering input in design, and document the studies in reports suitable for use in design studies (Task 6).

(b) Approach

The approach of this subtask will be to provide a probabilistic analysis of earthquakes along controlling active faulting, and to estimate maximum credible earthquakes for each active fault. These analyses will be completed by an interdisciplinary team utilizing the reconnaissance-level information obtained from Subtask 4.01 to 4.05. Reporting will be in a format suitable for use in selecting the design basis earthquakes, and will include thorough documentation that will be suitable for FERC and peer group review.

(c) Discussion

A panel of leading experts in seismology investigation and seismic design of major structures will be convened during this activity to review and comment on all study work undertaken and the findings thereof.

Overall management and coordination of Subtasks 4.01 to 4.05 is also incorporated in this subtask.

(d) Level of Effort

Task Force (WCC)	$138,000
Liaison and Review (Acres)	8,000
Review Panel	10,000
Total Subtask 4.06	$156,000

(d) Schedule

Weeks 18 through 52

Subtask 4.07 - Preliminary Ground Motion Studies

(a) Objective

Undertake a preliminary estimate of the ground motions (ground shaking) to which proposed project facilities may be subjected during earthquakes.

(b) Approach

The ground motion characteristics to be estimated include peak parameters (peak accelerations, velocities, and displacements), response spectra (describing the frequency content of ground shaking) and significant duration (describing the time duration of strong ground shaking). This initial assessment of ground motions will be made using information from the seismic geology (Subtask 4.05) and seismology (Subtask 4.02) studies. The ground motion estimates will be refined if necessary on the basis of additional information gathered during the second year. (See Subtask 4.13).

In consideration of ground motions, the terms "seismic exposure" and "seismic risk" are sometimes used interchangeably. However, for the purposes of this proposal they have two distinctly different meanings:

- "Seismic Exposure" is used to define the nature of the earthquake induced ground motion characteristics at a specific site;
- "Seismic Risk" is used to define the risk as probability of a structure at the project site being affected or destroyed by an earthquake. It reflects the degree to which the structure has been designed to cope with earthquakes.

Ground motions will be estimated using a probabilistic approach, usually called a seismic exposure analysis. In this approach, the probability of exceeding various amplitudes of ground motions is estimated, taking into account the frequency of occurrence of earthquakes from all significant seismic sources and the attenuation of ground motions from each source to the locations of project facilities. Earthquakes of various magnitudes, up to the magnitudes of maximum credible events, will be considered. Attenuation relationships will be derived from examination and analyses of earthquake recordings made in similar tectonic environments and in similar subsurface geologic conditions, including available recordings from Alaska. WCC has recently conducted a comprehensive state-of-the-art analysis of seismic exposure in Alaskan offshore areas (OASES, 1978). The results and data of this previous study, which included assessment of activity for major onshore faults (e.g., Denali Fault, Castle Mountain fault) as well as offshore faults (e.g., Benioff zone), will be extremely valuable to our progress study.

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The end products of this subtask will consist of estimates of the probability of exceedance during selected time periods (e.g., 100 years) of various levels of ground motions at the locations of each proposed major dam and other major facilities. For the long transmission lines and major access roads, the probability estimates will be given for appropriate segments of the systems. Probability levels and corresponding amplitudes of ground motions that may be considered in selecting project seismic design criteria will be discussed. For the dams, ground motion criteria will be consistent with ground motions associated with maximum credible earthquakes. For less critical project components, ground motion characteristics having a higher probability of exceedence would be used as design criteria.

(c) Discussion

It is widely recognized that neither the occurrence of future earthquakes nor the resulting ground motions at a site can be predicted with great accuracy even when the best available data and technology are employed. The fact is recognized in the above approach and considerable attention will be devoted to determining the reliability of the estimated design criteria.

The key interrelationships of this subtask and others are the following:

Projections of earthquake recurrence and identification of maximum credible earthquakes is an essential input to this subtask and will be accomplished in Subtask 4.06. The results of this subtask constitute essential input to Subtask 4.08 (Preliminary Analysis of Dam Stability) and Subtask 4.15 (Identification of Soils Susceptible to Seismically Induced Failure Along the Transmission Line and Access Road Routes).

The products of this task include the following:

- Estimates of the probability of exceedance during selected time periods (e.g., 100 years) of various degrees of ground motion at the location of each proposed major dam and other major project components.

- A discussion of and recommendations for project ground motion design criteria.

(d) Level of Effort

Task Force (WWC)	$31,000
Liaison and Review (Acres)	2,000
Total Subtask 4.07	$33,000

(e) Schedule

Weeks 24 through 52

Subtask 4.08 - Preliminary Analysis of Dam Stability

(a) Objective

Make preliminary evaluations of the seismic stability of proposed earth, rockfill and/or concrete dams during maximum credible earthquakes.

(b) Approach

These evaluations will be of a conceptual nature and will be undertaken as input to Task 6 design studies and determinations of the impact of seismicity on dam costs; i.e., on the requirements for design and/or treatment of foundations, design of dams, construction materials and placement requirements.

The preliminary evaluation of the adequacy of designs of earth and rockfill dams to resist seismic ground shaking will involve the following steps:

- Evaluation of strength characteristics under seismic loading conditions of in situ soils left in place in earth or rockfill dam foundations.

- Evaluation of key static and dynamic properties of embankment materials. Particularly important properties are the static and cyclic strength characteristics and permeability.

- Assessment of the potential for landsliding and large deformations through embankment or concrete dams and foundation during or following seismic ground shaking.

The cyclic strength characteristics of foundation soils will be assessed on the basis of field boring data and laboratory index and classification test data. For unfrozen sands in the foundation, blow counts from standard penetration tests (SPT's) in borings will be used to evaluate the resistance of the soils to liquefaction. Properties of embankment materials will be estimated on the basis of general description, grain size distributions, and compaction requirements of proposed borrow materials. This information will be supplemented by the experience of the project staff and information obtained from published data. In addition, six dynamic cyclic tests of proposed embankment or foundation materials are planned. The results of these tests will be compared with data for similar materials available in published literature and in the files of WCC.

The potential for landsliding in the embankments and their foundations will be analyzed using simplified analytical approaches and experience in similar studies. The key evaluations that are needed for the assessment of dam behavior are:

- the potential for generation and dissipation of excess pore water pressures in the materials during and following an earthquake (strongly dependent on permeability).

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- the potential for sliding using conventional stability analysis approaches and taking into account the effect of seismically-induced pore pressures on soil and rockfill strengths.

(c) Discussion

The execution of this subtask will involve an iterative approach. For the initial designs, the experience of the project team will be used to establish broad guidelines for material selection and design. These designs will be evaluated for seismic stability. These results will then be used to modify, if necessary, the designs which in turn may be checked by a second evaluation.

The interrelationships of this subtask to others are the following:

- input is required from Subtasks 4.07 - Preliminary Ground Motion Studies, Task 5 - Geotechnical Exploration and Task 6 - Design Development. Task 6 input will be particularly required from the subtasks dealing with preliminary designs of dams and descriptions of construction materials and placement requirements.

- outputs of this subtask will be used as input to Task 6 - Design Development, particularly for preliminary dam design.

The products of this subtask are:

- Preliminary evaluation of the seismic stability of embankment cross sections subject to maximum credible earthquake loading.

- Recommendations for changes in preliminary embankment cross sections, material compaction requirements, and foundation treatment if required for increasing seismic stability.

- Preliminary evaluations of requirements for design of concrete dams (arch or gravity, as required).

The required dynamic analyses of the embankments will be undertaken under Task 6 activities. Woodward-Clyde Consultants will provide ongoing consulting services for these analyses, under Subtask 4.14.

(c) Level of Effort

Task Force (WCC) $40,000
Liaison and Review (Acres) 4,000

Total Subtask 4.08 .... $44,000

(d) Schedule

Weeks 50 through 85

Subtask 4.09 - Long-term Seismologic Monitoring Program

(a) Objective

Develop a long-term seismologic monitoring program to provide a continuing source of seismological data for refinement of the seismic design aspects of the project during the detailed design phase.

(b) Approach

Based on the experience gained with the short-term seismologic monitoring program (Subtask 4.02) a detailed program of long-term monitoring and data analysis will be designed for implementation prior to the license award. This program will be designed to determine the background level of seismic activity on shallow crustal faults pertinent to the evaluation of possible reservoir-induced seismicity. Emphasis will therefore be placed on providing an inexpensive, reliable data collection facility and flexibility analysis procedures.

(c) Discussion

The long-term seismologic monitoring program will be developed on the understanding that arrangements will be made by APA for continued operation of the system and evaluation of data through construction of the Susitna Project and beyond. Appropriate documentation and operating manuals will be prepared for this purpose.

(c) Level of Effort

Task Force (WCC)	$ 61,000
Liaison and Review (Acres)	1,000
Total Subtask 4.09	$ 62,000

(d) Schedule

Weeks 100 through 130

Subtask 4.10 - Reservoir Induced Seismicity

(a) Objective

Refine the estimate for the potential for reservoir induced seismicity made in Subtask 4.03.

(b) Approach

The additional field data collected in Subtask 4.11 will be incorporated in a reassessment of the work done in Subtask 4.03.

(c) Level of Effort

Task Force (WCC) $9,000
Liaison and Review (Acres) 1,000

Total Subtask 4.10 ....$10,000

(d) Schedule

Weeks 83 through 91

Subtask 4.11 - Seismic Geology Field Studies

(a) Objectives

Perform seismic geology field studies to identify faults that may be active and in the vicinity of the selected dam sites.

(b) Approach

These data will be used in the final evaluation to identify the maximum credible earthquakes on each fault, and the recurrence of faulting and earthquakes along each fault. The results of this subtask will be used as input to Subtask 4.12 - Evaluation and Reporting. Planning of the field studies will be based on the results of Subtask 4.05 - Seismic Geology Reconnaissance and of Subtask 4.04 - Remote Sensing Image Analyses. We will also ensure that field studies be pursued at features that may affect project design at selected dam sites.

The subtask will include the following investigations which will be specifically designed for each feature to be studied:

- geologic mapping at a scale of 1:24,000.
- trenching of selected features
- borings
- test pits
- geophysical investigations
- age dating.

Compared to the work done in Subtask 4.05, the geologic mapping will include more detailed Quaternary data, and bedrock mapping at selected places along specific lineaments and geologic features (e.g. the Susitna fault and other features that may be fault-related). Age-dating studies will be undertaken to aid in the identification and correlation of geologic units. Trenches excavated across features that may be fault-related, or borings on either side of these features, will be used to aid evaluation of these features. The trenching (or boring) sites will be selected during the geologic mapping phase and will be located in areas considered to be suitable for assessing the nature of the faults and the degree of fault activity.

It is currently anticipated that approximately three trenching sites will be identified, with two trenches at each site. One site will be located along the Susitna fault, and an additional three sites along other features that are preliminarily identified as controlling features. During the course of the study, geophysical investigations, including seismic refraction lines and gravity or magnetic surveys will also be undertaken to aid in locating and evaluating the faults and the nature of the faulting.

(c) Discussion

All of the field exploratory work outlined above is incorporated in Subtask 5.06.

The data derived from these geologic studies on controlling features will be evaluated to assess the potential of these features as seismic sources. This process will include refining the estimate of the maximum magnitude of an earthquake that may occur along the feature, the frequency of occurrence of seismic events along the feature, the focal mechanism of the event, the distances from the dam sites at which the event may occur, and the type of faulting and the amount of fault displacement that may occur on these features. This data will form the basis for design values derived in Subtask 4.12.

Products derived from this Subtask will include:

- Documentation, tabulation, and an assessment of lineaments, mapped faults, and epicenter locations identified as potential controlling features.

- A map (scale 1:24,000) of the selected controlling features in the vicinity of the dam site.

- A geologic map (scale 1:24,000) and selected areas along the controlling features.

- Trench logs or core data of excavations or borings undertaken to evaluate the controlling features.

- The interpretation of geophysical data collected along the controlling features.

- Estimates of the maximum earthquake, the type of faulting and the amount of displacement that may occur during that event, the distance of the earthquake from the dam sites, and the frequency of occurrence of earthquakes of that magnitude along each controlling feature.

- An evaluation of significant, related seismic effects that may occur in the dam site and reservoir area.

(c) Level of Effect

Task Force (WCC)	\$137,000
Liaison and Review (Acres)............	5,000
Total Subtask 4.11	\$142,000

(d) Schedule

Weeks 64 through 95

Subtask 4.12 - Evaluation and Reporting

(a) Objectives

Refine the evaluation of the seismic environment and the earthquake source parameters derived in Subtask 4.06, complete the reporting of all the fieldwork and studies undertaken in Subtasks 4.01, 4.05 and 4.09 to 4.11, and provide coordination and management to Subtasks 4.09 to 4.11.

(b) Approach

All the additional field data collected for the Long-Term Monitoring Program - Subtask 4.09, Reservoir-Induced Seismicity - Subtask 4.10 and Sesimic Geology Field Studies - Subtask 4.11 will be utilized to refine the preliminary evaluations undertaken in Subtask 4.06. The same basic methodology as employed in Subtask 4.06 will be used.

The seismic review panel will again be convened during this subtask.

(c) Level of Effort

Task Force (WCC)	$143,000
Liaison and Review (Acres)	10,000
Review Panel	15,000
Total Subtask 4.12	$168,000

(e) Schedule

Weeks 70 through 104

Subtask 4.13 - Ground Motion Studies

(a) Objectives

Refine the estimate of ground motion characteristics made in Subtask 4.07.

(b) Approach

Based on the additional information gathered during the second year of the study, the work done in Subtask 4.07 will be reviewed, and, if necessary, appropriate adjustments made.

(c) Level of Effort

Task Force (WCC)	$11,000
Liaison and Review (Acres)	1,000
Total Subtask 4.13	$12,000

(d) Schedule

Weeks 75 through 104

Subtask 4.14 - Dam Stability Consulting Services

(a) Objective

To provide consulting assistance to the Acres design group engaged in the feasibility design of the dams.

(b) Approach

During the feasibility design stage Acres will undertake all the necessary dynamic analyses required to complete the design of the dams under Task 6 - Design Development Activities. WCC will act in a general consultancy role and respond to specific questions raised by the Acres team. The seismic review panel will also be consulted under this subtask.

(c) Level of Effort

Liaison and Review (WCC)	$ 7,000
Review Panel	10,000
Total Subtask 4.14	$17,000

(d) Schedule

Weeks 80 through 120

Subtask 4.15 - Soil Susceptibility to Seismically-Induced Failure

(a) Objective

Identify those areas along the transmission line and major access road routes that appear to be underlain by soils particularly susceptible to seismically-induced ground failure such as liquefaction or landsliding.

(b) Approach

The intent of this subtask is not to provide detailed design-level evaluations of soil failure potential. Rather it is to identify those areas having conditions that could significantly affect costs of transmission lines or access roads by requiring rerouting, special designs or contingency measures.

This subtask will be accomplished by a review of the geologic mapping, soils data, topographic data and estimated seismic ground motions (Subtask 4.07) along the routes. The identification of failure-susceptible soils will be accomplished mainly on the basis of experience of performance of soil deposits during earthquakes. Simplified analytical approaches and empirical correlations will be used to aid in assessing the potential for liquefaction of unfrozen, saturated, cohesionless sands. Possible remedial measures for areas of high failure potential will be briefly described. These include rerouting, special foundations, soil excavation and/or filling.

(c) Discussion

The results of this subtask will enable estimates to be made of additional costs required for design and construction of facilities due to seismicially-induced soil failure potential. However, if the consequences of failure are not too severe, and/or if the probability of damaging earthquake ground motions is low, it may be appropriate to utilize conventional designs but to provide contingency plans and budgets for repairs. For example, considerable lateral spreading and settlements of access roads might be acceptable consequences during an earthquake but would generate additional repair cost to the project.

Inputs to this subtask will be obtained from Subtask 4.07 - Ground Motion Studies, Subtask 5.04 - Field Program 80, and Subtask 5.06 - Field Program 81. Outputs from this task will be utilized in the design and costing of these facilities.

The products of this subtask are:

- Delineation on maps and/or in tabular form of areas having high potential for seismically induced ground failure.

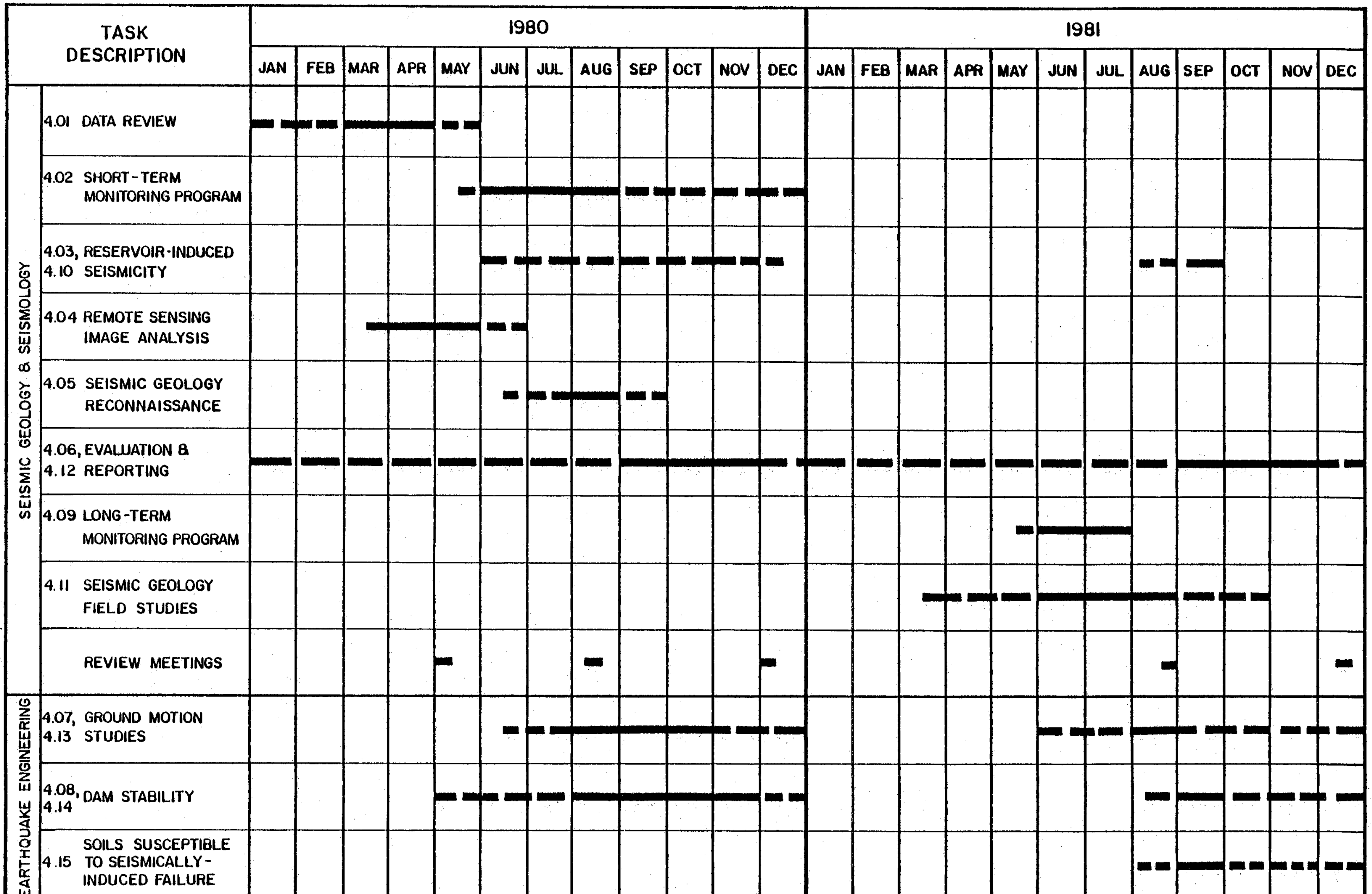
- Brief descriptions of possible remedial measures for facilities in areas of high failure potential.

(d) Level of Effort

Task Force (Acres)	$16,000
Support and Liaison (WCC)	5,000
Total Subtask 4.15	$21,000

(e) Schedule

Weeks 53 through 74



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SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T4.1 : TASK 4 SCHEDULE

TASK 5: GEOTECHNICAL EXPLORATION

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A.5.6 - TASK 5: GEOTECHNICAL EXPLORATION

(i) Task Objectives

To determine the surface and subsurface geology and geotechnical conditions for the feasibility studies of the proposed Susitna Hydroelectric Project, including the access roads and the transmission lines.

(ii) Task Output

The primary outputs of Task 5 will consist of comprehensive documentation of geotechnical exploration undertaken at the Devil Canyon and Watana sites, reservoirs, and access roads and transmission line routes. This documentation will include the following:

- geologic maps
- geologic sections
- descriptive and graphic borehole logs
- descriptive test trench logs
- field inspection borehole and test trench log
- photogeologic map
- borehole rock core photographs
- low level air photointerpretation
- seismic and resistivity bedrock profiles
- radar imagery interpretation maps
- geotechnical exploration program summaries (1980, 1981, 1982)
- data summaries for
  - -- in-hole seismic testing
  - -- borehole camera studies
  - -- laboratory testing
- geotechnical exploration summary reports (1980, 1981)

(iii) List of Subtasks

Subtask 5.01 - Data Collection and Review
Subtask 5.02 - Photointerpretation
Subtask 5.03 - Exploratory Program Design (1980)
Subtask 5.04 - Exploratory Program (1980)
Subtask 5.05 - Exploratory Program Design (1981)
Subtask 5.06 - Exploratory Program (1981)
Subtask 5.07 - Exploratory Program Design (1982)
Subtask 5.08 - Data Compilation

(iv) Subtask Scope Statements

For the purposes of this Plan of Study, the geotechnical exploratory programs are essentially divided into first-, second- and third-year stages (1980, 1981 and 1982). Exploratory work to be undertaken in 1982 and beyond is not included in Task 5 activities. Preparation of the program for 1982 is nevertheless included on the understanding that the 1982 program will be initiated prior to submission of the FERC license application, but is not an essential prerequisite to that submission. The 1980 geotechnical exploration program will be designed to identify and investigate in limited detail those geological and geotechnical conditions which will significantly affect the feasibility of the proposed dam projects. Limited preplanning opportunities and climatic constraints are such that investigations in 1980 will be somewhat limited in scope, and the data limited in detail. Emphasis will therefore be placed on identifying and investigating to the maximum extent the most adverse geotechnical conditions encountered.

The objectives of the 1981 geotechncial exploration program will be to investigate in more detail those geological and geotechnical conditions, both general and adverse, which will significantly affect the design and construction of the proposed dam projects. Exploration along the routes selected for the access roads and transmission lines will also be undertaken in 1981. Although the scope of the exploratory work and the data produced in 1981 will still be somewhat limited, the exploratory program will be designed to establish with reasonable confidence the feasibility and total cost of the project, access roads and transmission lines. The exploratory program in 1982 will be yet more detailed. This and subsequent programs will be aimed at providing greater certainty in the design of major dams and structures with a view towards further insuring the safety of structures while minimizing potential project cost overruns due to unforeseen geotechnical design conditions. The geotechncal exploration programs will be specifically designed to be complementary to the work already completed.

The geotechnical exploration programs in the field will also be severely constrained by difficulties of access and maneuverability of equipment imposed by weather conditions and the requirements for environmental preservation. Full account has been taken of these constraints in developing this Plan of Study.

A detailed discussion of the individual subtasks follows. It should be stressed that the exploration program design is based on the assumption that Watana and Devil Canyon are the selected sites.

Subtask 5.01 - Data Collection and Review

(a) Objective

Collect and review all existing geological and geotechnical data pertaining to the Susitna Project area, including the access road and transmission line corridors and the Susitna River basin.

(b) Approach

Data to be collected at this stage include, but are not limited to the following:

- previous regional and site geological mapping and studies
- published or unpublished geological and geotechnical data and reports from federal, state, academic or private sources
- air photos and high level ERTS photos of the project area, including the proposed access road and transmission line
- geophysical survey, remote sensing and seismicity studies and data pertaining or relevant to the project

A short field visit will be made to the proposed damsites for preliminary geologic interpretation. This will assist in making the preliminary damsite and dam alignment selections in Task 6. This in turn will determine the design of the exploratory investigation program. The data and results of review will be assembled into a brief report with appropriate Appendixes. These documents will be made available for subsequent use by all project design and study groups.

Borehole rock cores from previous investigations will also be examined in Anchorage. Contacts will be made with the University of Alaska to gather geologic and geotechnical data. A check will be made for mining interests in the project areas. Data pertaining to geological and geotechnical problems associated with the construction of large embankments, access roads and transmission lines will be collected. Discussions will be held with the U.S Corps of Engineers concerning details of the past field studies.

This task will be undertaken by Acres' Anchorage staff with appropriate support from R&M, whose local knowledge is substantial.

(c) Level of Effort

Task Force (Acres)	$ 13,000
Task Force (R&M)	$ 10,000
Total Subtask 5.01	$ 23,000

(d) Schedule

Weeks 0 through 9

Subtask 5.02 - Photointerpretation

(a) Objective

Perform air photointerpretation and terrain analysis of the Watana and Devil Canyon damsite areas, reservoir areas, construction material borrow areas and access road and transmission line corridors, and identify adverse geological features and geotechnical conditions that would signficantly affect the design and construction of the project features.

(b) Approach

Photointerpretation will be based on available air photography obtained under Subtask 5.01, and new aerial photos of a larger scale obtained under Task 2 for the damsites, reservoirs, and construction materials borrow areas, access road and transmission line corridors.

The initial photoanalysis will utilize existing air photos obtained either from private or government sources. These photos are believed to be high level and consequently small scale. They will, however, serve to establish preliminary surface geology, including geomorphology, geologic history, glacial geology, lithology and stratigraphy, structural geology, permafrost characteristics and geohydrology and engineering geology. Land forms will be identified. Alluvial or glaciofluvial deposits of previous sand and gravel, glacial deposits of impervious till and floodplain deposits of poorly drained, compressible silty materials will be located. The distribution, quality and stratigraphic relationships of rock types will be identified.

Photo analysis will also be used to generally delineate or infer permafrost areas and buried channels. Groundwater regimes will also be studied and unstable and/or erodible slopes identified.

A short field study will be required to verify the photointerpretation analysis. This will be performed early in the first field season (1980).

(c) Discussion

New air photos produced under Task 2 will be available at the end of the first field season. These low level, high resolution, large scale photos will have two purposes:

- preparation of second year exploratory investigation program
- production of accurate topographic maps on which to base subsequent geological mapping and design studies.

Photointerpretation under this subtask will be undertaken by Acres' Anchorage staff and closely coordinated with the photointerpretation work done by WCC (Subtask 4.05) in order to eliminate unnecessary duplication of work.

The results of photointerpretation will be documented in the form of brief summary reports and appended photographs and maps to highlight the principal findings.

(c) Level of Effort

Task Force (Acres) .... $ 40,000

(d) Schedule

Weeks 5 through 41

Subtask 5.03 - Exploratory Program Design (1980)

(a) Objective

Design the geotechnical exploratory investigation programs for 1980 for Watana and Devil Canyon damsites, dam construction materials, and reservoir areas, and along the access road route.

(b) Approach

The design of the various exploratory investigations will be based on the results of the data collection and review study (Subtask 5.01) and the air-photo interpretation study (Subtask 5.02). Input from the preliminary access road studies under Task 2 will also be required.

Generally, these exploratory investigations will consist of geologic mapping, auger drilling and sampling, test trenching, seismic and resistivity studies, airborne radar imagery techniques and laboratory testing. In cases where environmental damage is a problem or accessibility is poor, test trenches will be replaced by shallow auger drilling by helicopter. The design will specify the following details:

- area to be geologically mapped
- position and extent of seismic and resistivity lines
- areas to be investigated by airborne radar imagery techniques
- types and numbers of laboratory tests.

Investigations for access roads will be confined to geologic mapping and radar imagery. Table A5.3 and A5.5 detail the type and extent of investigations and laboratory testing that are currently proposed elsewhere. The design of the exploratory investigations will be flexible enough to permit changes during the execution of the work. These changes will become evident as the field studies proceed.

(d) Discussion

Work under this subtask will be performed by Acres' Anchorage staff with support in logistical planning provided by R&M and close liaison with WCC.

In the design of the exploratory investigations, full advantage will be taken of the extensive investigations previously undertaken. These include drilling, test pitting, geologic mapping and seismic surveys by the US Corps of Engineers at Watana damsite, and the drilling investigations and seismic studies at Devil Canyon by the US Corps of Engineers and the US Bureau of Reclamation.

- Watana Site

At the Watana damsite area, 17 boreholes have been drilled for a total of 3,340 feet and 11 boreholes have been drilled, totalling 1,815 feet in the right bank spillway and buried channel area. Reconnaissance reservoir mapping and fault mapping has been performed by Kachadoorian. A total of 19 auger and diamond drill

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holes and 26 test pits have been made in the construction material areas. A total of 69,600 feet of seismic surveys has also been completed.

These investigations have tentatively shown the Watana site to be suitable for an earth and rock-fill dam. The dam foundation contains small shear zones but no major shear zones have been found. Construction materials appear to be available and suitable. Although the important Susitna fault traverses the reservoir, no active faults have as yet been proven in the reservoir. There has been a suggestion that the Tsusena Creek alignment downstream of the dam may represent discontinuity of some kind. Discontinuous permafrost exists locally. Overburden depth in the riverbed at the site appears to be less than 80 feet. A deep buried and potentially leaky channel exists in the right abutment.

Further studies at Watana are required to prove the absence of major faults in the riverbed and in the abutments, to delineate permafrost zones and identify its characteristics, prove the availability and suitability of the construction materials, confirm good quality rock in the spillway and powerhouse area and define the buried channel and identify its geohydrologic properties.

- <u>Devil Canyon Site</u>

At the Devil Canyon damsite, 13 boreholes totalling 1,350 feet have been drilled in the dam area and another eight boreholes totalling 735 feet have been drilled in the left abutment buried channel area. Nineteen test trenches have been excavated in potential borrow areas. A total of 3,300 feet of seismic surveys have been performed. Although there has been little geologic mapping of the abutments at Devil Canyon, the investigations have shown this site to be suitable for a concrete gravity structure.

Major shear zones have not been found in the dam foundation area but minor shear zones are present. Although no active faults have been found in the reservoir, a deep buried channel exists in the left abutment. Some potential construction material areas have been indentified.

Further studies at Devil Canyon are required to prove the absence of major faulting in the riverbed and abutments or active faults in the reservoir. Studies are also needed to determine the site geology in more detail, to delineate and evaluate the left abutment buried channel and to prove the availability and suitability of construction materials.

(d) <u>Level of Effort</u>

Task Force (Acres)	$ 15,000
Support and Liaison (R&M)	$ 3,000
Total Subtask 5.03	$ 18,000

(e) Schedule

Weeks 12 through 20

TABLE A5.3

PROPOSED GEOTECHNICAL EXPLORATORY PROGRAM - 1980

Area	Exploration	PROJECT STRUCTURES/FACILITIES: Devil Canyon Dam & Reservoir	PROJECT STRUCTURES/FACILITIES: Watana Dam & Reservoir
Damsite	Geologic Mapping	yes	yes
	Geophysical (seismic and resistivity)	3 - 900 ft. lines at buried channel site 3 - Oblique 450 ft. lines across river channel 2 - 1,000 ft. lines on right abutment	1 - 5,000 ft. line at proposed spillway site 2 - Oblique 1,500 ft. lines across river within upstream portion of dam
	Diamond Drilling	1000 ft.	600 ft.
	Airborne radar imagery	± 3,500 ft. at right and left abutment and saddle dam site	± 4,000 ft. at right and left abutments
Dam Construction Materials		One established and two new borrow areas	Four established and two new borrow areas
	Geologic Mapping	yes	yes
	Portable Auger Drilling	20 - 10 ft. deep holes in the two proposed borrow areas	20 - 10 ft. deep holes in the two proposed borrow areas
	Geophysical (seismic and resistivity)	2 - 1,000 ft. lines in the two proposed borrow areas	2 - 1,000 ft. lines in the two proposed borrow areas
	Test Trenches	30 trenches in the three borrow areas	30 trenches in three of borrow areas
Reservoir Basin	Geologic Mapping	yes	yes
	Portable Auger Drilling	10 - 10 ft. deep holes	10 - 10 ft. deep holes
	Geophysical (seismic)	2,000 ft.	6,000 ft. at site of right bank relict channel
	Diamond Drilling	100 ft.	100 ft.
	Airborne Radar Imagery	10,000 ft.	20,000 ft.

Subtask 5.04 - Exploratory Program (1980)

(a) Objective

Perform initial surface and subsurface investigations at Watana and Devil Canyon sites and reservoir areas and access road routes to establish general and specific geological and foundation conditions.

(b) Approach

The program will essentially be designed to:

- obtain more details on the surface and subsurface geology and foundation conditions at the Watana and Devil Canyon damsites.
- complete the preliminary evaluation of the availability and suitability of the various construction materials required, i.e. fine and coarse aggregate, fine and coarse rockfill, impervious earth fill, pervious and semipervious granular fill and riprap.
- determine the surface geology and geotechnical conditions in limited detail to the Watana and Devil Canyon reservoir areas.
- provide preliminary geologic assessments of the proposed access road routes.

Field work programs will generally be designed by Acres' Anchorage office personnel with input from the Buffalo design group as needed. Seismologic input will be provided by WCC and logistical support by R&M. All field operations will be performed by R&M with appropriate technical inspection and supervision by Acres and to a lesser extent the WCC staff.

(c) Damsites

The proposed exploratory investigations will supplement previous work in establishing general and specific surface and subsurface geologic and foundation conditions at the Devil Canyon and Watana damsite areas.

The investigations will comprise geologic mapping, diamond drilling, geophysical, seismic and resistivity studies and airborne radar imagery, to substantiate and augment the available information on:

- depth, distribution, type, stratigraphy and properties of overburden
- distribution, type, quality, degree of weathering and permeability of bedrock
- location, orientation, width, continuity, filling characteristics and capability of major discontinuities in bedrock such as faults

- orientation, frequency, opening, continuity and filling of joints in bedrock

- permafrost characteristics including location, temperature profile and soil type

- groundwater regime

Emphasis will be placed on locating and studying adverse geological features. Such features will include faults, excessive depths of overburden in riverbeds and buried channels which will significantly affect the design and cost of a dam project at a given site.

The geologic mapping at Watana and Devil Canyon damsites will be undertaken to supplement and verify the previous geological mapping carried out by the U.S. Corps of Engineers and the U.S. Geological Survey (Kachadoorian).

The photointerpretation (Subtask 5.02) will be checked in the field, and adverse geologic features and conditions suggested in the photointerpretation will be investigated on the ground. The geologic mapping will utilize the most recent topographic maps. Aerial photos and survey lines normal to the river will be used as reference in the field. The geologic mapping will be performed primarily by Acres' Anchorage office personnel with assistance from R&M.

Geophysical seismic refraction and resistivity studies will be carried out primarily to determine bedrock depth in deep overburden areas such as buried relict channels and the riverbed area. This work will be done at both damsites. Seismic work can be misleading in permafrost regimes and resistivity provides a reasonable alternative.

Bedrock depth profiles will be prepared from these studies.

The geophysical work, including the interpretation, will be undertaken by R&M, with review and liaison by Acres' Anchorage office personnel.

(d) Construction Materials

The exploratory investigations for construction materials will comprise geological mapping, portable auger drilling, geophysical seismic and resistivity studies, test trenching and laboratory testing.

The geologic mapping, drilling, trenching and geophysical work will generally be used to establish the limits, depth, stratigraphy, type and properties of the borrow materials. The limits, type and properties of potential quarry rock will be similarly determined. The explorations will also serve to verify the photointerpretation and previous studies by the Corps of Engineers. Groundwater and permafrost conditions will be investigated and extensive soil sampling undertaken. Rock outcrops will be mapped and test trenches excavated by small track-mounted backhoes to a depth of about 13 feet.

Geophysical techniques such as seismic refraction and resistivity will be used to prove the depth of the potential borrow materials and the groundwater depth. Airborne radar imagery or low sun angle air photos will be used to assist in identifying the permafrost areas.

A moderate amount of laboratory testing of the borrow material will be conducted at this stage. The testing will comprise routine soil identification tests including unit weight, moisture content, consistency, Atterberg limits and gradation.

Standard Proctor compaction tests will also be performed on pervious and impervious material and permeability of compacted impervious materials assessed. Some dynamic shear strength tests under high confining pressures will also be performed on impervious and pervious materials. Potential concrete aggregate samples will be tested for sodium sulfate soundness, acidity and Los Angeles abrasion characteristics.

All field exploration work under this subtask will be undertaken by R&M. Laboratory testing on borrow material will be performed by R&M with some assistance from WCC .

Design liaison, supervision and review will be provided by Acres' Anchorage office personnel.

(e) Reservoir Areas

The exploratory investigations to be carried out for the reservoir areas will include geologic mapping, portable auger drilling and geophysical seismic refraction surveys.

The primary aim will be to map those geological features and geotechnical conditions in the reservoir area which may seriously affect the reservoir performance. Such features may include previous buried channels or faults in the reservoir rim which may jeopardize the reservoir watertightness, faults which may be activated under reservoir impounding and natural slopes which may become unstable or erodible with reservoir impounding or reservoir drawdown.

The geologic mapping will be on a reconnaissance scale. The airphoto interpretation (Subtask 5.02) will be checked on the ground and specific adverse features suggested in the photointerpretation will be investigated. The distribution, type and properties of overburden and bedrock materials will be checked against the photointerpretation. Portable auger drills will be used to drill shallow holes to assist in establishing the subsurface geology and geologic history. Low sun angle air photos or airborne radar imagery techniques will be utilized to help delineate general permafrost areas which may cause unstable slopes once the reservoir is impounded. Specific test areas will be identified in which auger borings utilizing a modified CRREL core barrel will be used to sample permafrost. Thermal probes will be installed in the holes to determine temperature profiles.

No buried channels have been found to date in the reservoir rim. If such channels are suggested in the photointerpretation, geophysical seismic studies will be initiated to determine the depth and nature of the overburden and channel widths.

A relatively minor amount of laboratory testing will also be undertaken in this phase. This will comprise routine soils identification tests on those samples taken in the reservoir studies.

All field and laboratory work undertaken under this subtask will be performed by R&M. Design liaison, supervision and review will be provided by Acres' Anchorage office personnel.

(c) Level of Effort

Task Force (Acres)	$ 231,500
Task Force (R&M)	$ 712,000
Helicopter Transport	$ 250,000*
Total Subtask 5.04	$ 1,193,500

* Includes Task 7 requirements

(d) Schedule

Weeks 20 through 40

Subtask 5.05 - Exploratory Program Design (1981)

(a) Objective

Design the geotechnical exploratory investigation programs for 1981 for Watana and Devil Canyon damsites, dam construction materials and reservoir areas, and for the selected access road and the transmission line routes.

(b) Approach

The design of the 1981 program will be determined to a large extent by the results of the 1980 investigations and other preliminary design activities in progress.

The 1981 investigations will be by means of a confirmation of the 1980 program of geologic mapping, auger drilling and sampling, test trenching, seismic and resistivity studies, airborne radar imagery techniques and laboratory testing. In addition, diamond drilling and in-hole seismic, borehole camera and instrumentation studies will be performed. The program will be designed to obtain more detailed information on the subsurface geology in general, on rock mass deformation properties, rock mass jointing characteristics and slope movement. Locations, depths and inclinations of the boreholes and methods and priorities of drilling will be defined, together with identification of which holes will be tested by in-hole seismic methods or studied by borehole camera.

The design of the exploratory investigations for the access road and transmission line will also be performed in this subtask. The access road and transmission line corridors will traverse terrain varying from flat, wet marshland and soft overburden to dry, sloping rock hillsides. No field investigations have been performed to date on the access road or transmission line.

Explorations along the selected transmission and access road routes will include drilling and sampling. To comply with environmental constraints, it is anticipated that this exploration will be undertaken using track-mounted hollow-stem auger drill rigs during the winter months of February and/or March. In wooded areas, helicopter supported auger rigs will be used to permit access. Exploratory investigations for the road will include delineation of areas of permafrost, unstable slopes, soft foundations and availability and suitability of construction materials. Investigations for the transmission line will be similar but will also be planned to determine probable tower foundation conditions.

Tables A5.4 and A5.5 outline the details of the proposed 1981 investigation and testing program as currently anticipated.

Design of the 1981 field program will take full account of the constraints necessary to comply with federal and state environmental preservation and related requirements.

(c) Discussion

The program envisaged at this time has been based on selection of the Watana and Devil Canyon sites for development. Preparation of the program design will be closely coordinated with activities of Tasks 2, 4, 6 and 8. This will insure that the data obtained will provide cost effective input to the selected locations and designs of major structures, particularly the dams.

The field exploration data will be used to confirm or appropriately modify the adopted design criteria for embankment construction materials and foundations. Emphasis will be placed on insuring the safety of structures and the minimization of potential construction cost overruns.

Work under this subtask will be performed by Acres' Anchorage staff with support in logistical planning provided by R&M and close liaison with WCC seismic investigations.

(d) Level of Effort

Task Force (Acres)	$ 35,000
Support and Liaison (R&M)	$ 21,000
Total Subtask 5.05	$ 56,000

(e) Schedule

Weeks 59 through 70

ACRES

TABLE A5.4

PROPOSED GEOTECHNICAL EXPLORATORY PROGRAM - 1981

Area	Type of Exploration	POWER STRUCTURES/FACILITIES: Devil Canyon Dam & Reservoir	POWER STRUCTURES/FACILITIES: Watana Dam & Reservoir	Other
Damsite	Geologic Mapping	yes	yes	
	Diamond Drilling	4 holes in right abutment (power-house and dam) 4 holes in left abutment (saddle dam and diversion tunnel) 3 holes in riverbed*	2 holes in relict channel, right abutment 2 holes in right abutment spillway and dam) 2 holes in left abutment (power-house and dam)**	
	In-hole Seismic	1500 ft.	1000 ft.	
	Borehole Camera	1500 ft.	1200 ft.	
	Test Trenching	15 trenches	15 trenches	
Dam Construction Materials		Three borrow areas from 1980 program plus two new areas	Six borrow areas from 1980 program plus two new areas	
	Auger Drilling	10 - 30 ft. deep holes	12 - 30 ft. deep holes	
	Diamond Drilling	10 - 50 ft. deep holes in five borrow areas	12 - 50 ft. deep holes in six borrow areas	
	Test Trenching	30 trenches in two new areas	30 trenches in two new areas	
Reservoir Basin	Geologic Mapping	yes	yes	
	Portable Auger Drilling	10 - 10 ft. deep holes	10 - 10 ft. deep holes	
	Diamond Drilling	3 - 100 ft. deep holes, 1 - 200 ft.	3 - 100 ft. deep holes, 1 - 200 ft.	
	Geophysical/Seismic	1000 ft.	1000 ft.	
	Reservoir Slope Monitoring	1 - 200 ft. slope indicators	1 - 200 ft. slope indicator	
Access Road Route (Approx. 50 miles)				ACCESS ROAD
	Geologic Mapping			yes
	Airborne Radar Imagery			10 miles (20% of total length)
	Portable Auger Drilling			25 - 10 ft. deep holes
	Hollow Stem Auger / Diamond Drilling			15 - 50 ft. deep holes
Transmission Line Route (Approx. 360 miles)				TRANSMISSION LINE
	Geologic Mapping			yes
	Portable Auger Drilling			35 - 10 ft. deep holes (one per 10 miles)
	Hollow Stem Auger / Diamond Drilling			35 - 50 ft. deep holes (one per 10 miles)
Major Fault Lines				FOR SEISMIC STUDY
	Test Trenching			12 test trenches at six sites
	Geophysical (seismic)			
	Gravity Survey			

NOTES:

*Average depth of holes is expected to be 275 feet and total drilling length approximately 3,025 feet, of which 1000 feet will be completed complete in the 1980 program. This would increase total at site to 5,025 feet.

**Average depth of holes is expected to be 350 feet and total drilling length approximately 2,000 feet, of which 600 feet will be completed in the 1980 program. This would increase total at site to 5,450 feet.

Subtask 5.06 - Exploration Program (1981)

(a) Objective

Complete surface and subsurface investigations at Watana and Devil Canyon sites, reservoir areas, access roads and transmission line routes to the extent necessary to provide adequate data to confirm project feasibility and for submission of the FERC license application.

(b) Discussion

This program will essentially be designed to:

- complete the investigation of the surface and subsurface geology and foundation conditions at the Watana and Devil Canyon dam site to a level sufficient to insure safety of design of major structures and foundations and reliable project construction cost estimates.

- establish detailed geological conditions and geotechnical properties of potential construction material sources to insure the adequate availability of embankment fill.

- undertake a detailed evaluation of the geological features and geotechnical conditions in the Watana and Devil Canyon reservoir areas to insure the safety and integrity of the impoundments.

- to determine the surface and near surface geology and foundation conditions along the selected access road and transmission line routes to insure technical and economic feasibility for submission of the FERC license application.

Field work programs will generally be designed by Acres' Anchorage Office personnel with input from the Buffalo design group as needed. Seismologic input will be provided by WCC and logistical support by R&M. All field operations will be performed by R&M with appropriate technical inspection and supervision by Acres and WCC staff as necessary.

(c) Damsites

The proposed exploratory investigations at the dam sites will comprise geologic mapping, diamond drilling, geophysical in-hole seismic testing, borehole camera studies, test trenches and laboratory testing.

The exploratory methods used in this program will be generally aimed at collecting more detailed information to augment and complement that obtained in 1980. The surface geological mapping will be completed. Outcrops will be located by survey and mapped in greater detail. Adverse geological features will be further investigated on the surface. Exploratory drilling will be performed at both sites in the various structure areas on both abutments and in the riverbed to determine foundation conditions. Diamond drills of the Longyear 34 type or equivalent will be used. Split-spoon and Shelby tube sampling, as well as standard penetration tests will be performed in the overburden. NX-size core will be drilled and double-tube core barrels will be employed to maximize the core recovery.

Some boreholes will penetrate to a depth equal to the head to evaluate deep seated conditions. Permeability testing will be performed and piezometers will be installed. Major discontinuities suggested by previous drilling or surface mapping will be further explored by drilling and verified. Potential leakage channels, the depth of weathered rock on the abutments and the depth of overburden in the riverbed will be probed by drilling. Riverbed drilling at each site will be undertaken during the winter months to take advantage of the ice cover. Drills will be moved by helicopter. Drilling operations will be performed by R&M with inspection and review by Acres' Anchorage office personnel.

The evaluation of the foundation rock conditions will be further supplemented by in-hole geophysical testing and borehole camera studies. The in-hole geophysical testing which will be done by R & M will provide a relative measure of the rock quality and more specifically, the deformation modulus. The borehole camera studies which will be done by Acres will serve to evaluate the in-situ rock jointing characteristics.

Permafrost conditions will be more closely studied with the assistance of thermal probes installed in boreholes. Test trenches will be used to assist in the geological mapping process.

Laboratory testing will be carried out for the purpose of describing the overburden characteristics. Samples of foundation overburden material which may be left in place beneath the dam structure will also be tested for static and dynamic shear strength under high confining pressure. Samples of weak, clay-filled seams in the rock will be taken and subjected to direct shear strength testing. Samples of rock core will be subjected to sonic velocity and for unconfined uniaxial compressive strength tests. Laboratory sonic velocities will be compared to the field in-hole geophysical testing. Samples of jointed rock will also be tested for frictional shear strength along discontinuities. Most of the laboratory testing will be performed by R&M with some assistance from WCC and technical supervision by Acres' Anchorage office personnel.

(d) Construction Materials

The exploratory investigations will essentially comprise diamond drilling, test trenching and laboratory testing. Some geologic mapping and geophysical studies will also be undertaken. Emphasis will be placed on firming up the quantity estimates and proving the quality of available borrow materials. New borrow areas may also be explored. Drilling will be carried out in both borrow areas and potential rock quarries. Split-spoon and Shelby tube sampling and standard penetration tests will be performed. Drills will be moved by helicopter. Drilling will be done by R&M, with inspection and review by Acres.

A considerable amount of laboratory testing of the borrow material samples will be undertaken in addition to the routine soil identification tests, Proctor compaction testing, permeability testing and concrete aggregate testing, including static, dynamic and direct shear strength testing. Strength tests will consist of consolidatedundrained tests with pore pressure measurements on pervious and impervious materials. The dynamic tests will also be done under high confining pressure and on pervious and impervious material. A limited number of direct shear tests may be made on impervious materials.

Laboratory testing on the borrow materials will be performed mainly by R&M with assistance from WCC and technical inspection by Acres.

(e) Reservoir Areas

To avoid unnecessary duplication of work, this task will be closely coordinated with the WCC Task 4 studies.

The investigations to be carried comprise geologic mapping, auger and diamond drilling, seismic refraction surveys, reservoir slope monitoring and laboratory testing. Adverse features identified in the 1980 program will be further explored.

A minor amount of laboratory soil identification testing will be undertaken for the reservoir studies. These tests will provide data which will assist in establishing the geology.

With the exception of the geologic mapping, all of the above work will be done by R&M, with technical supervision by Acres.

(f) Access Road Routes

The exploratory investigations along the selected access road corridors will comprise geologic mapping and airborne radar imagery studies to further amplify the 1980 work. In addition, in 1981 portable auger and hollow-stem auger, diamond drilling and laboratory testing work will be undertaken.

Preliminary access route selection studies will be undertaken in Task 2 and detailed designs under Task 6. The field investigations will be designed to achieve a minimum level geological and geotechnical understanding of the conditions along the selected route on a reconnaissance scale. This will permit an assessment of the general conditions as well as those problems likely to significantly affect the design and construction of the access road. Feasibility cost estimates will then be facilitated.

Exploratory investigations will generally concentrate on the surface and near surface soil and rock distribution, types and properties, permafrost limits, groundwater conditions, potential landslide areas and the availability and suitability of construction materials. Potential bridge sites will require more detailed studies of the abutment foundation conditions.

The type of investigation and scope of work for a particular type at a given site will depend on the anticipated foundation conditions, as determined by air-photo interpretation and geological inference, and the foundation requirements.

The general study approach will be first to perform the hollow-stem auger drilling and sampling at designated sites during the winter months. A track-mounted drill can best carry out this work with least cost and environmental damage, except in wooded areas as previously indicated. Later, in the snow-free season, geological mapping, airborne radar imagery, portable auger drilling and sampling will be done. The mapping will establish the general overburden and bedrock geology (surface distribution, types and properties) and will verify the photointerpretation. The airborne radar imagery will be used to delineate areas of permafrost and freedraining granular deposits. Shallow auger holes will probe the near surface geology. Soil samples from the winter and summer drilling will be selected for routine laboratory identification tests as well as unconfined compressive strength tests and Proctor compaction tests.

The laboratory work and most of the exploratory work will be performed by R&M with geological mapping and technical supervision by Acres' Anchorage office staff.

(g) Transmission Line Routes

The exploratory investigations along the transmission line will comprise geologic mapping, airborne radar imagery studies, portable auger, hollow-stem auger, diamond drilling and laboratory testing.

The most feasible transmission line route will be selected in Task 8. The basic approach adopted to geotechnical explorations will be similar to that for the access road route.

The investigations will be performed with specific tower foundations in mind, i.e., anchored footings in rock, spread or mat footings in granular deposits, piles or caissons in silt and clay. Sections of transmission line on well-drained, granular deposits of rock will require less detailed study. Detailed drilling and sampling, however, will be done in areas of soft, compressible or thaw-unstable foundations. Vane shear strength testing will be required in soft compressible foundations. In these potential problem areas, information will be required on the type, stratigraphy and properties of the soil foundation. Foundations of towers at points of line direction change will require special attention due to the most stringent foundation requirements. Foundations of towers at the ends of long spans or on potentially unstable slopes will also require special attention.

R&M will perform the field explorations and laboratory testing with gelogic mapping and technical supervision by Acres.

(h) Level of Effort

Task Force (Acres)	$	337,500
Task Force (R&M)	$	1,180,000
Helicopter Transport	$	500,000
Total Subtask 5.06	$	2,017,500

* Including Task 7 requirements

(i) Schedule

Weeks 56 through 91

ACRES

Subtask 5.07 - Exploratory Program Design (1982-1984)

(a) Objective

Design of the geotechnical exploratory investigations program for 1982-1984 to obtain basic design data for Watana damsite, dam construction materials and reservoir area, and for the selected access road and transmission line routes.

(b) Approach

A great deal of exploratory information will have been obtained prior to 1982 and a substantial amount of safe, reliable, project component designs undertaken prior to submission of the FERC license application. Although this work will be adequate to insure project feasibility with a reasonable level of confidence, further exploratory work is essential to minimize the possibility of unforeseen conditions which could potentially impact the safety and cost of major structures. This exploratory work will provide the necessary input to the ongoing detailed design work through commencement of project construction. Based on the Corps studies to date, it is currently anticipated that construction of the Watana diversion scheme will be the first activity to follow award of the FERC license. The adopted diversion scheme will in turn depend to a large extent in the layout of the major project components. It is therefore anticipated that following submission of the FERC license application for the Susitna Project, further exploration investigations will be necessary to fully determine in detail all significant geologic and geotechnical factors affecting:

- the diversion tunnels and cofferdams
- the dam and other major structure foundation treatment and designs
- the availability of adequate supplies of cofferdam construction materials
- subsurface design conditions at the proposed locations of underground structures
- the potential for ground instability as a result of erosion adjacent to diversion tunnel spillway and tailrace discharges
- the watertightness and integrity of the reservoir
- design of access roads

(c) Discussion

The extent and scheduling of this additional exploratory work will be influenced to a great extent by the findings of the 1980 and 1981 programs and the development of project designs. This subtask will be undertaken in late 1981 and early 1982 with a view to insuring continuity of exploratory work in 1982 and beyond. The major portion of this subtask will be undertaken by Acres' Anchorage office staff with appropriate input and support by WCC and R&M.

The scheduling of the 1982-1984 program will be significantly affected by the availability of access facilities. Although certain portions of the program can be accomplished within the same environmental constraints as those undertaken in 1980 and 1981, other portions of the 1982-1984 program will require the access road to be available for use. Thus, for the purpose of this plan of study, it is assumed that the access road will be designed and the necessary permits obtained by commencement of the 1982 construction season.

For purposes of this plan of study, it has been assumed that the selected access road route will commence at a staging area to be constructed at the railroad at Gold Creek and essentially follow the left bank of the Susitna River to the Watana site. Bridges will be required at several ravine and river crossings. Bridge abutment foundations will be somewhat more closely investigated than the general alignment of the road. Slightly modified routes and bridge sites may also be investigated. New borrow areas may be studied. Proposed high rock and soil cuts will be explored for stability. Further drilling may be required to firm up the permafrost characteristics.

The 1982-1984 program of exploratory investigations for transmission lines will comprise further hollow-stem auger drilling and sampling, vane shear testing, laboratory testing and geological mapping, if necessary. These tools will be used to obtain considerably more data on the general and the geotechnical conditions which affect the design of the transmission line.

Pump well testing in the riverbed will be required in areas of deep and pervious riverbed overburden. This testing will be used to estimate representative permeability values for design of riverbed excavation dewatering systems.

The 1982-1984 laboratory testing program will be designed to determine reliable values for the overburden properties. These data, together with standard penetration test data will be essential in defining the extent of removal of materials under the proposed dams.

(d) Construction Materials

More diamond drilling, trenching and laboratory testing will also be required in the construction material areas. This program will be designed to further substantiate the availability and properties of rockfill, impervious, semipervious and pervious earthfill, rockfill and rip-rap materials. Sampling will again be by split spoon or Shelby tube. Laboratory testing as described in Table A5.5 will be further expanded to include several large triaxial shear strength tests in earth and rockfill under high confining loads.

(e) Reservoir Areas

The proposed 1982-1984 investigation program will be designed to further amplify the information obtained in 1980 and 1981. Final drilling and instrumentation will be completed in the reservoir areas. The program will include diamond drilling, reservoir slope monitoring and laboratory testing. These exploratory tools will be used to obtain considerably more detailed data on geotechnical conditions in potential problem areas such as pervious buried channels in the reservoir rim or unstable rservoir slopes. Further geologicl mapping may be required for adverse features identified in the 1981 program. Potentially unstable slopes will continue to be monitored together with piezometric levels.

A relatively small amount of laboratory testing will be undertaken for the reservoir area in this phase.

(f) Access Roads and Transmission Lines

The scheduling of the remaining exploration for the access roads is such that this work will have to be completed in early 1982. For transmission lines, on the other hand, the program can be spread over a longer period without affecting overall scheduling of the project. The data requirements for the design of the roads and transmission lines, although much less in quantity than for the dams, are similar in scope. Minimum detailed information on the overburden properties such as compressibility, shear strength, permeability and compaction characteristics, and on the bedrock, such as rock quality and strength, will be required for the basic design.

Thus, for the access road and transmission line areas, additional foundation drilling, sampling and laboratory testing will be required in this program. Firm quality and quantity estimates of construction materials will be required for the access road. In the transmission line, drilling and sampling will be required for each tower foundation. Foundation drilling for the access roads and transmission lines is best undertaken in the winter months by means of a track-mounted, hollow-stem auger diamond drill.

(g) Level of Effort

Task Force (Acres)	$ 50,000
Support and Liaison (R&M)	22,500
Total Subtask 5.07	$ 72,500

(h) Schedule

Weeks 95 through 120

Subtask 5.08 - Data Compilation

(a) Objective

Assemble all geotechnical exploratory data into documents suitable for inclusion in relevant project reports and licensing documentation.

(b) Approach

Data to be compiled will include:

- air-photo interpretation
- geologic mapping
- seismic and resistivity data
- borehole logs
- auger hole logs
- test trench logs
- airborne radar imagery data
- laboratory test data

The test trench logs will be prepared to describe the overburden in the borrow areas. Laboratory testing data will be incorporated into these logs. Seismic and resistivity profiles will be prepared to show the ground surface and the bedrock topography. This information will be combined and used to prepare preliminary site geology maps and sections which will form the basis for the preliminary geotechnical assessments to be performed in Task 6. The maps and sections will show the overburden and bedrock surface distribution, types and characteristics, faults, jointing, permafrost areas, potentially unstable slope or poor foundation areas and buried channels. Geologic maps will range from reconaissance scale in the reservoir areas to limited detail in the damsite areas.

Borehole and test trench logs for the 1982 program will be used to substantiate and improave the geological maps and sections and to show surface and subsurface geology and geotechnical conditions of importance to the design and construction of the dams, access roads and transmission lines.

(c) Discussion

Although R&M and WCC will provide some input to this subtask, all final compilation of data will be undertaken by Acres in its Anchorage and Buffalo locations.

Compiled data will be attached to the periodic reports issued as the work progresses. Detailed reports summarizing all the exploratory investigations will be prepared at the end of each exploration season.

(d) Level of Effort

Task Force (Acres) .... $ 200,000

(e) Schedule

Weeks 5 through 125

TASK 6: DESIGN DEVELOPMENT

A.5.7 - TASK 6: DESIGN DEVELOPMENT

(i) Task Objectives

To undertake planning studies, to evaluate, analyze and review all previous engineering studies related to hydroelectric development of the Upper Susitna River Basin and to develop preliminary engineering design and cost information for Watana and Devil Canyon Dam sites with all associated intake, outlet works, spillways and power facilities to allow preparation of a project feasibility report.

(ii) Task Output

The primary output of Task 6 will be a logical and systematic development of the requisite project features. Alternative sites for dams and power developments will be evaluated. Alternative arrangements at each site will also be considered. One such alternative will involve a 30-mile long power tunnel from Watana to Devil Canyon to eliminate the high dam at that site. A Development Selection Report will be issued on or about Week 65 of the Study for review and approval by Alaska Power Authority. Preliminary findings of the study will be discussed on or about Week 50, in order to establish whether or not work on two dam sites should continue or whether more viable alternatives exist and should be examined. Design transmittals will be at appropriate points in the study. All necessary input from parallel tasks including hydrology, geotechnical, economic, seismic, survey, and environmental studies will be factored into the planning studies and the development of the various features of the project. Engineering evaluation criteria and project definition will be developed. If sites are found to be technically viable, economically feasible and environmentally acceptable, additional studies and investigations will be conducted to establish the feasibility of the project and the optimum scale and sequence of development.

(iii) List of Subtasks

Subtask 6.01 - Review of Previous Studies
Subtask 6.02 - Investigate Tunnel Alternative
Subtask 6.03 - Evaluate Alternative Susitna Developments
Subtask 6.04 - Evaluation of Arch Dam at Devil Canyon Site
Subtask 6.05 - Development Selection Report
Subtask 6.06 - Watana/Devil Canyon Staged Development Alternatives
Subtask 6.07 - Preliminary Watana Dam Alternatives
Subtask 6.08 - Preliminary Devil Canyon Dam Alternatives
Subtask 6.09 - Establish Watana Design Criteria
Subtask 6.10 - Establish Devil Canyon Design Criteria
Subtask 6.11 - Preliminary Design Watana Dam
Subtask 6.12 - Preliminary Design Devil Canyon Dam
Subtask 6.13 - Dam Selection Report
Subtask 6.14 - Spillway Design Criteria
Subtask 6.15 - Watana Spillway Alternatives
Subtask 6.16 - Devil Canyon Spillway Alternatives
Subtask 6.17 - Preliminary Design Watana Spillway
Subtask 6.18 - Preliminary Design Devil Canyon Spillway

Subtask 6.19 - Spillway Selection Report
Subtask 6.20 - Access and Camp Facilities
Subtask 6.21 - Watana Diversion Scheme
Subtask 6.22 - Devil Canyon Diversion Scheme
Subtask 6.23 - Optimize Watana Power Development
Subtask 6.24 - Optimize Devil Canyon Power Development
Subtask 6.25 - Optimize Dam Heights
Subtask 6.26 - Preliminary Design Watana Power Development
Subtask 6.27 - Preliminary Design Devil Canyon Power Development
Subtask 6.28 - Power Development Report
Subtask 6.29 - Watana General Arrangement
Subtask 6.30 - Devil Canyon General Arrangement
Subtask 6.31 - Feasibility Report

(iv) Subtask Scope Statements

Plate T6.1 illustrates the interrelationship of various subtask studies and the logical input of various other tasks. The subtasks have been specifically arranged to make maximum use of input from various other tasks including Tasks 1 through 5 and 7 through 9. A detailed discussion of the objectives, the methodologies and associated costs and scheduling for each subtask follows. Note that for the purpose of this plan of study, it has been assumed that only Watana and Devil Canyon sites will be considered for additional field exploration and analysis. However, in the initial subtasks, all possible sites and modes of development on the Susitna will be examined to confirm that the Watana/Devil Canyon arrangement is the most appropriate.

Subtask 6.01 - Review of Previous Studies and Reports

(a) Objective

Assemble and review all available engineering data, siting and economic studies relating both to the Susitna hydropower development and to alternative potential sites.

(b) Approach

Reports and also field reconnaissance studies generated by various agencies including USBR, the Corps of Engineers, Kaiser and others will be reviewed to assess the design assumptions for the sites. Information obtained from these reports, including reservoir storage and power head, site evaluation, geologic and seismic conditions, topographic features and other special physical and environmental constraints, will be tabulated. Total potential for power development at each site and the associated costs will be assembled in tabular form; costs will be updated to current levels for comparison. Sites studied will include all those identified in the previous reports.

Layouts for all sites and special constraints for each site will be identified. All conceptual design parameters will be developed to update the cost of each site to a uniform level in order to rank the sites. The task will include the indexing of all basic information that could be used in analysis under Subtask 6.03. Indexing will include all basic information on nature, type and extent of geotechnical investigations previously completed, maximum level of development considered for each site, type and size of dam selected, type and size of spillway considered for each site studied, and on-line dates considered in the previous reports. Other data to be indexed will include reservoir storage, average, maximum and minimum flow, regulated flow, power capacity and energy development at each site, equivalent construction costs and other factors, such as special environmental and seismic impact on each site.

(c) Discussion

The level of study previously undertaken for each site varies considerably, not only with respect to geotechnical investigations and preliminary planning, but also in relation to hydrologic and economic assessment. Project ranking techniques and cost updating criteria will necessarily have to include additional cost parameters and analysis. These data will be used at the specified level of development as an input to Task 6.03.

In order to meet the overall objectives of the subtask, a critical review and assessment will be made of all technical information on power capacities; and other constraints for the development of each site will be identified. Previous work has identified six dam sites for which ranges of heights and power installation have been considered. These sites will be analyzed in order to select the projects which are both technically feasible and economically attractive for initial construction and are compatible with the plan for hydropower development of the entire basin. It is likely that some of the sites will be rejected in initial screening because of poor foundations or because of very high cost of development. Previous studies have demonstrated that the Watana and Devil Canyon sites are probably the most favored; but if the studies under this task indicate otherwise discussions with the Alaska Power Authority will be scheduled immediately.

All cost data from the previous reports will be updated to 1980 cost levels. As project costs are highly dependent not only upon site foundation conditions, size of spillway and outlet works, but also upon whether a low level outlet is provided, costs will be adjusted to a basically common design.

(d) Level of Effort

Task Force (Acres)	$ 50,000
Task Force (R&M)	5,000
Total Subtask 6.01	$ 55,000

(e) Schedule

Weeks 25 through 40

Subtask 6.02 - Investigate Tunnel Alternatives

(a) Objective

To investigate the feasibility of a scheme for development of the Susitna River eliminating the Devil Canyon project by the substitution of a tunnel-supplied power plant fed from the Watana dam site.

(b) Approach

A preliminary review of the proposed Watana/Devil Canyon development of the Susitna River suggests that a feasible alternative, which would allow the elimination of the major reservoir formed by the Devil Canyon dam, would comprise the construction of a power tunnel starting at, or near, the currently proposed Watana site and terminating at a power plant near the proposed Devil Canyon site as illustrated in Plate T6.2.

In addition to the reduced environmental impact brought about by the elimination of the Devil Canyon dam and lake, the tunnel alternative would eliminate major dam, reduce the size of one power plant, and allow a much larger proportion of the construction work to be located underground, shielded from severe Alaskan winters.

Potential disadvantages of the tunnel alternative include loss of power output due both to head losses in the tunnel and to the necessity to maintain flow in the river between Watana and the lower power plant tailrace. The considerable length of the tunnel would require the provision of several construction adits with corresponding environmental impacts during construction.

In order to make an initial assessment as to whether this alternative should be carried forward into more detailed evaluation, the following activities are proposed:

(1) On the basis of the material assembled in Subtask 6.01, a number of tunnel alternative arrangements will be identified. Some preliminary concepts are shown in Plate T6.2. Several others incorporating different tunnel alignments and intake/power plant locations will be identified.

(2) These initial alternatives will be subjected to a gross screening to eliminate those least likely to meet economic, technical or environmental requirements. Preliminary layouts will be developed for those remaining and major dimensional and design characteristics will be established.

(3) Preliminary quantity and cost estimates will be prepared for the selected tunnel alternatives, together with corresponding cash flows.

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(4) Estimates of capacity and energy for each of the alternatives will be developed.

(5) The most attractive of the tunnel alternatives will be compared from the technical, economic, and environmental standpoints with other options for the river development identified in Subtask 6.03.

(c) Discussion

The tunnel alternative to the Devil Canyon project would appear, from initial review, to have some rather attractive features which may warrant careful evaluation. From the environmental standpoint, the elimination of the very large Devil Canyon reservoir must be a very significant step. This may, of course, be offset to some extent by the increased live storage to be provided at Watana and by the possible wider spread of construction activity during tunnel construction. Initial "order of magnitude" cost estimates seem to indicate at least a trade-off level of cost for the tunnel alternative, without assessing the impact on the schedule and power generation capabilities of the long power tunnel.

(d) Level of Effort

Task Force (Acres) $63,000

(e) Schedule

Weeks 30 through 50

Subtask 6.03 - Evaluate Alternative Susitna Developments

(a) Objective

To identify the most appropriate scheme for development of the Susitna River on the initial basis of technical feasibility and cost.

(b) Approach

Primary input for this subtask from the cost and technical standpoints will be derived from the review of previous studies (Subtask 6.01) and from the investigation of the "tunnel alternatives" (Subtask 6.02). Further input will be provided from the hydrological studies undertaken in Task 3 and from the public participation program carried out under Task 12. This subtask will involve the development, comparison and subsequent ranking of all reasonably feasible combinations of sites and power facilities identified either in the previous studies or in the course of Acres studies to this time. Economic parameters for a range of dam heights and power installations will be developed for each site and for the complete river development; these will be analyzed by computer to identify the most promising scheme.

Specific activities will include:

- Evaluation of six previously identified sites including Susitna I and II, Denali, Vee, Watana and Devil Canyon and other sites, for which data will be obtained from the review of literature (Subtask 6.01).

- Data on rated head, regulated flow, yield and power available from previous reports for these sites will be developed and the value and cost of power for each site will be compared. Only previous layouts and engineering information generated will be evaluated.

- Data on foundation conditions, availability of construction materials, limits of development of each site, access conditions, seismic and environmental conditions for each site will be reviewed in site-ranking studies.

- Sites with extremely poor foundation conditions and other serious constraints related to seismic or environmental impact will be rejected.

- A summary report on this ranking study will be prepared.

(c) Discussion

By this stage of the study, costs of alternative power and energy will be available for economic comparison and development of cost-benefit ratios of each individual site, and by combination for each set of developments discussed above. It would appear from previous studies that the combination of Watana and Devil Canyon sites is the most promising development, and it is expected that the results of this work will verify this. However, if the results of the study indicate otherwise, the layout, costs and details of the alternative arrangement will be brought to the same level as the studies for the 1979 report by the Corps of Engineers for the Watana and Devil Canyon sites. The evaluation will rank the sites or the combination of various sites with power capability at each, and establish associated costs and cost-benefit ratios for each combination studied. Alternatives will include combinations of Watana dam sites and power tunnels. The results of these studies will be documented in the form of a memorandum which will form a basis for further studies. The report will explain the mechanics of the evaluation process and the rationale of specific site and combinations of sites, foundation suitability, availability of construction materials, economic comparison from cost/benefit analysis indicate the environmental impact on each such site. The selected alternative will be that which proves to be the most favorable for development of the Upper Susitna Basin.

(d) Level of Effort

Task Force (Acres)	$60,400
Task Force (TES) Included in Task 1 ...	--
Total Subtask 6.03	$60,400

(e) Schedule

Weeks 40 through 60

Subtask 6.04 - Evaluation of Arch Dam at Devil Canyon Site

(a) Objective

To make a preliminary assessment of the feasibility of an arch dam at the Devil Canyon site.

(b) Approach

The original development at the Devil Canyon site recommended by the Corps of Engineers incorporated a 635 foot high double curvature thin arch dam with a crest length of 1,370 feet. Following critical comment by the OMB, the Corps, in their Supplemental Feasibility Report (1979), proposed alternative which would replace the arch dam with a more costly gravity dam. The primary rationale was the reduced sensitivity of the gravity dam to foundation and abutment conditions.

We will critically review the feasibility of an arch dam at the Devil Canyon site from both economic and technical aspects, as well as the overall safety aspect.

The review and evaluation will comprise:

(a) Assembly and review of all available material relating to the arch dam design recommended in the Corps' report and earlier in Bureau of Reclamation reports.

(b) A critical examination of all geotechnical data relating to the foundation and abutment conditions at the proposed dam site. These data may well include further information obtained in the course of the ongoing field investigations.

(c) A critical review of the seismic conditions at the site, particularly in the light of material developed in the course of Task 4 Seismicity Studies.

(d) A review of current design practice in relation to high arch dam design in seismically sensitive areas.

(e) The development of the draft design of an arch dam appropriate to the conditions at Devil Canyon. Design will be accompanied by associated schedule and cost estimate, including impact on associated structures.

(f) Review of proposed design by Special Consultants and modifications as required.

(g) Final evaluation of feasibility of the arch dam from the technical, economic and safety standpoints and development of a recommendation as to whether an arch dam or another design of dam should be carried through to the licensing documentation.

(c) Discussion

The arch dam design at Devil Canyon was supplemented with an alternative conventional gravity design by the Corps in the 1979 Supplemental Report. Economic feasibility of the project using more conservative design approaches was demonstrated. An underlying concern regarding the safety of arch dams in high zones is evinced by the recent decision regarding the Auburn dam.

However, it is of interest to note that as reported in a recent issue of Water Power and Dam Construction, April 1979, not one failure of a concrete dam directly caused by earthquakes has ever been recorded. Linear analytical techniques for evaluation of the response of concrete structures to seismic forces have evolved, the most widely used being the finite element technique. Acres recently utilized this technique to evaluate the Karun high arch dam proposed in Iran with a height of 325 meters. In general, concrete dams perform very well when subjected to earthquakes. Of the types available, arch dams generally have proven to perform the best and buttress dams have been subject to the severest damage because of abrupt change in section and the resultant stress concentrators.

The V-shape canyon with a ratio of 2.15 (width at crest level--1,370 feet to depth--635 feet) is favorable for a double curvature arch dam. As an example, the experience of dam building in Japan can be cited. The average seismic intensity experienced at various types of Japanese dams (in 12 point scale) is:

- gravity dams 9.8
- arch and arch gravity 10
- rockfill dams 8.5

Such high arch dams as Kurobe (186 m), Nagovado (155 m), Iagisawa (131 m), Takane (130 m), Kawamata (120 m) and others were built in areas with earthquake intensity 10 to 11 points.

There are a number of approaches which can be used to condition the abutments of arch dams to weaknesses of the rock. Stresses in the foundation may be reduced, not only by increasing the abutment thickness of the arch, but also by using abutment pads. In addition to being a very satisfactory means of spreading arch thrusts, abutment pads provide an efficient means of bridging faults and other weaknesses in the foundation. Abutment pads are applied on the world's highest arch dams at Ingury (U.S.S.R. 271 m) and were proposed for the Auburn dam (U.S.A. 209 m).

Severe weather conditions will cause serious problems for both the dam types. Besides the necessity to prevent freezing and cracking of concrete during construction, a serious consideration will be consolidation of the dam body and rock base.

In Russian dams built in Siberia, grouting joints between monoliths were replaced by slots 1.2 m wide backfilled with concrete after cooling the monolith below the average annual temperature (the average annual temperature in the core of the dam is 2°C to 3°C higher than the average annual temperature of the area). If the area average temperature is below zero, the concrete should be cooled to a temperature of not more than +1 to +2°C. Such a procedure involves a long time and high cost. The Russian Mamakan and Zeya dams are hammerhead type (buttress type). This type of dam provides easy access to the slots from the hollow spaces. Concreting of the slots is performed after warming up the surfaces of slots by means of electric heaters. After filling the reservoir, the temperature of the dam body will rise and the concrete plugs will be compressed.

Another problem is prevention of the negative effect on the stress state of the dam caused by freezing of the downstream part of the dam. Static analysis and model tests performed for gravity dams located in Siberia (annual average temperature -2°C to -4°C) showed that for the winter, the frost can penetrate to the center of the dam, causing opening of the horizontal joints and, as a consequence, tensile stresses on the upper face of the dam (reductions in the compressive stresses of up to 30 percent were demonstrated). For this reason, hammerhead or massive buttress dams with heating inside the hollows were built in Russia (Mamakan, Zeya, Bratsk, Buchtarma) instead of massive gravity dams. At the Mamakan dam, the electric heating system is in operation for one to one and a half months a year, and the capacity of the heaters is 80 kW. Another method of preventing freezing is to insulate the downstream face of the dam.

Consolidation of an arch dam is much easier because arch dams do not have longitudinal construction joints. Concreting of the slots after cooling the monolith below the average temperature will produce a similar effect to heating gravity monoliths. In general, arch dams, since they are more flexible and smaller volume working structures, can cope more easily with severe temperature conditions than gravity dams.

Nonetheless, some improvements of the presently proposed arch dam are likely to be necessary.

(a) An abutment pad should be used. It functions as a transition structure between arch and rock, and as such, may be thickened, widened and reinforced as necessary. In addition, the abutment pad may be used to improve symmetry of the canyon profile.

(b) A two centered dam layout with two separate pairs of lines of centers, one for each side of the dam, should be used to cope with the unsymmetrical shape of the canyon.

(c) The slenderness of the dam is $\frac{85.6}{635} = 0.135$ (base thickness to height), and it requires reevaluation in light of seismic and temperature conditions.

The slenderness coefficient should probably be increased to 0.16 and the base thickness to 0.16 x 635 = 101.6 feet (31 m).

Note, however, that even if it is considered that an earthfill, rockfill dam or concrete-gravity dam should be considered for FERC licensing application, some background information should be developed for an arch dam. Later studies may possibly indicate technical feasibility or economic and environmental desirability, and the option to revert to the arch design should be maintained open for as long as possible.

(d) Level of Effort

Task Force (Acres) $13,400

(e) Schedule

Weeks 45 through 65

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Subtask 6.05 - Development Selection Report

(a) Objective

To document the results of the initial studies undertaken to establish the optimum development of the Susitna River.

(b) Approach

This task will essentially comprise the detailed documentation of the work undertaken in Subtask 6.03 to compare and evaluate alternative means of developing the full hydroelectric potential of the Susitna River. The end product report will, in addition to providing APA with an interim recommendation as to the continued direction of the study, be an essential vehicle for the transmission of information to other tasks of the overall study, and in particular to Task 7 - Environmental Studies, Task 8 - Transmission Studies and Task 9 - Cost Estimates and Schedules.

The principal activites in this subtask will comprise:

- Assembly and review of material developed in Subtasks 6.01 through 6.03.

- Assembly and review of material developed in other parallel tasks to date, with particular reference to environmental studies (Task 7), and to Tasks 3 through 5 covering hydrology, seismicity and geotechnical exploration. Of particular interest from these parallel studies will be the preliminary identification of major impacts on the feasibility of various alternatives under study.

- Assembly of a draft report incorporating the key findings of the studies to date and putting forward draft recommendations for the direction of continuing studies.

- Detailed review of the draft report with APA and Engineering Review Panel.

- Finalization and issue of report.

(c) Discussion

This report will be developed in close consultation with the APA and will be issued as a public document. A key facet will be the recommendation, arising from the studies in Subtask 6.01 through 6.03, as to whether or not the Watana/Devil Canyon combination is the most appropriate mode of development of the Susitna River. The balance of the study program set out in this Plan of Study has been assembled on the assumption that Watana/Devil Canyon will be selected. Should this not prove to be the case, a major reassessment will have to be made of the scope, cost and schedule for the balance of the work program leading to license application.

(d) Level of Effort

Task Force (Acres) $14,000
External Review Panel 20,000

Total Subtask 6.05 .... $34,000

(e) Schedule

Weeks 50 through 65

Subtask 6.06 - Watana and Devil Canyon Staged Development

(a) Objective

Review the potential for staged development of Watana and Devil Canyon to best meet projected power and energy requirements and develop a staged construction plan.

(b) Approach

It is to be expected that the rate of load growth in the geographical area to which the Susitna Project will contribute will be such that it may be possible to obtain significant economies by a carefully-staged sequence of construction and power facility installation. This construction sequencing will have to be appropriately integrated with basic construction scheduling, diversion and impounding requirements for the two developments. The starting point and primary source of input data for this subtask will be the evaluation of alternative modes of development completed under Subtask 6.03. The principal activities to be undertaken include:

- From the power studies undertaken in Task 1, the anticipated rate (or range of rates) of load growth will be established and agreed upon with APA.

- Using the scheme of development recommended in Task 6.04 as a basis, a series of alternative sequences of development will be assembled. These alternative sequences will incorporate phasing of dam, power plant and transmission construction designed to match the rate(s) of load growth obtained above.

- Preliminary cost estimates will be developed for each stage of each of the development sequences.

- Estimates will be prepared of power and energy output throughout each sequence of development.

- Construction cost estimates will be converted to annual cash/flow figures.

- The comparative economics of the various sequences will be compared on a net present worth basis using Acres' ECON computer program to identify the most economic alternative. The comparisons will be made for a range of interest and discount rates.

- Other aspects of the two or three most attractive alternatives will be examined to assess potential environmental impacts.

- The most appropriate sequence of development for preliminary design of the Watana and Devil Canyon projects will be selected and design transmittal for APA review will be prepared.

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(c) Discussion

The ultimate sequence of development could involve partial-height dam construction, as well as partial installations of power plant capacity. Those sequences which involve operation at intermediate water levels will require not only that special provisions be made in intake and spillway designs, but also that the units be capable of continuous, reliable and efficient operation at part head. Preliminary layout sketches will have to be prepared for each of the stages of development for each sequence, both to ensure that any potential construction or design problems are identified and to provide a basis for the take-off of preliminary quantities and costs.

Although it is obviously unwise to prejudge the issue at this stage, it may well be that any attempt to extend the construction/installation schedule to match the load demand will prove to be uneconomical because of the high costs associated with extended maintenance or restarting of a construction operation in the severe environment of the Susitna River sites. Costs associated with construction in this climate will be factored into the economic analyses.

(d) Level of Effort

Task Force (Acres) $57,400

(e) Schedule

Weeks 60 through 75

Subtask 6.07 - Preliminary Watana Dam Alternatives

(a) Objective

Establish the most appropriate type of dam for the Watana Site.

(b) Approach

On the assumption that the preliminary studies completed in Subtasks 6.01 through 6.03 show that the two-dam Watana/Devil Canyon scheme of development is preferred, this subtask will review all previously available data, and new information developed in the course of this program of study to determine the most appropriate design for the Watana Site. The following specific activities are envisaged:

- Assemble all available information for the Watana dam site with regard to the following:
  - -- topography (from Task 2)
  - -- soil conditions (Task 5)
  - -- rock conditions (Task 5)
  - -- construction materials (Task 5)
  - -- seismic conditions (Task 4)
- Develop preliminary design of alternative dams; these may include:
  - -- concrete gravity/buttress
  - -- concrete arch
  - -- rockfill/earthfill
- Prepare preliminary layout sketches of the selected designs and obtain preliminary estimates of principal quantities, including:
  - -- excavation (soil and rock)
  - -- grouting
  - -- concrete and formwork
  - -- rockfill/earthfill
  - -- special fill materials such as transition or core material
- Review impact of alternative dam designs on other structures including:
  - -- diversion tunnels and associated cofferdams
  - -- spillway and outlet works
  - -- intake/power tunnel/powerhouse systems

  Develop first-order cost estimates to measure ultimate effect on overall cost of the facility for the various types of dam
- Develop preliminary cost estimates for alternative types of dam, giving appropriate recognition to costs associated with:
  - -- material sources
  - -- weather conditions
  - -- labor availability

- Prepare construction schedules for the alternative types of dam, and prepare annual cash flow estimates for the dams and for the significant costs associated with ancillary structures. Prepare summarized present-worth comparison of costs.

- Review "other" factors, such as unknown foundation conditions, construction considerations, seismicity and environmental effects which might influence the selection of dam type.

- Assemble and assess results of subtask analyses, and select type of dam for recommendation to the Engineering Panel and APA for ongoing studies.

(c) Discussion

The design proposed by the Corps of Engineers for the Watana dam comprises an 810 foot high rockfill structure with an inclined central impervious core; the core, and a "semi-porous fill" zone, is flanked by two fine/coarse filter zones. The Corps reports indicate that explorations to date have demonstrated the availability of sufficient quantities of material for the core and semi-pervious zones, and suggest that rockfill for the shells will be obtained from the excavations for the spillway and from quarries opened for the purpose.

The purpose of this subtask will essentially be to review the dam selection made by the Corps in the light of the preliminary studies and additional field exploration carried out to date during this study program. It is, of course, recognized that a rockfill/earthfill dam, which can be constructed from locally available materials and which may be less sensitive to unknown foundation conditions, is most likely to be the best choice for a site of this type. However, it will be appropriate to make a careful review of this selection before proceeding further with the design program to ensure that certain other features of concrete-type dams, such as reduced intake, spillway and diversion costs, might not offset the apparent advantages of the rockfill/earthfill design.

(d) Level of Effort

Task Force (Acres) $41,000

(e) Schedule

Weeks 60 through 75

Subtask 6.08 - Preliminary Devil Canyon Alternatives

(a) Objective

Establish the most appropriate axis and type of dam for the Devil Canyon Site.

(b) Approach

If the preliminary studies completed in Subtasks 6.01 through 6.03 show that the two-dam Watana/Devil Canyon scheme of development is preferred, this subtask will review all available data, collected previously, and new information developed in the course of this program of study to determine the most appropriate design for the Devil Canyon Site. Subtask 6.04 provides input for reviewing the feasibility of an arch dam at Devil Canyon. After the most favorable alternative is selected, various axes for the dam will be selected for economic comparison. The following specific activities are envisaged:

- Assemble all available information for the Devil Canyon dam site with regard to the following:

  -- topography (from Task 2)
  -- soil conditions (Task 5)
  -- rock conditions (Task 5)
  -- construction materials (Task 5)
  -- seismic conditions (Task 4)

- Develop preliminary design of alternative dams; these may include:

  -- concrete gravity/buttress
  -- concrete arch (using, if appropriate, material developed in Subtask 6.04)
  -- rockfill/earthfill

- Prepare preliminary layout sketches of the selected designs and obtain preliminary estimates of principal quantities, including:

  -- excavation (soil and rock)
  -- grouting/draingage
  -- concrete and formwork
  -- rockfill/earthfill
  -- special fill materials such as transition or core material

- Review impact of alternative dam designs on other structures including:

  -- diversion tunnels and associated cofferdams
  -- spillway and outlet works
  -- intake/power tunnel/powerhouse systems

  Develop first-order cost estimates to measure ultimate effect on overall cost of the facility for the various types of dam

- Develop preliminary cost estimates for the alternative types of dam, giving appropriate recognition to costs associated with:

  -- material sources
  -- weather conditions
  -- labor availability

- Prepare construction schedules for the alternative types of dam, and prepare annual cash flow estimates for the dams and for the significant costs associated with the ancillary structures. Prepare summarized present-worth comparison of costs.

- Review "other" factors, such as unknown foundation conditions, construction considerations, seismicity and environmental effects which might influence the selection of dam type.

- Assemble and assess results of subtask analyses, and select type of dam for recommendation to Engineering Panel and APA for ongoing studies.

(c) Discussion

The original design recommended by the Corps of Engineers for the Devil Canyon site was a double curvature arch dam; as discussed in Subtask 6.04. This was subsequently supplemented by an alternative conventional gravity dam to ensure that the estimate contained sufficient cost to allow construction of either type should site conditions allow. The feasibility of the construction of an arch dam will be re-examined specifically in Subtask 6.04, and should results of that work indicate no reason why it should be eliminated from further contention, it will be included amongst the alternatives examined here.

(d) Level of Effort

Task Force (Acres) $30,400

(e) Schedule

Weeks 60 through 75

Subtask 6.09 - Establish Design Criteria for the Watana Development

(a) Objective

To establish preliminary design criteria for the Watana hydroelectric development.

(b) Approach

Documentation of the following criteria related to the design of the Watana development will be initiated in this subtask:

- Hydraulic:
  - reservoir levels
  - storage volumes
  - rule curves
  - power flows
- Geotechnical:
  - foundation conditions
  - foundation treatment requirements
  - construction materials properties
  - seismic design conditions
  - slope stability requirement, soil and rock
- Structural:
  - loading conditions
  - uplift pressures
  - wind loads
  - temperature conditions and loads
  - material design properties
  - stability analysis procedures
- Mechanical:
  - turbine design requirements
  - power plant mechanical systems
  - gate design requirements
  - crane design requirements
- Electrical:
  - generator design requirements
  - power plant electrical systems
  - transmission requirements
  - ancillary electrical equipment requirements
- General:
  - design codes and standards
  - special Alaska or site-related requirements
  - transportation limitations
  - ice conditions

(c) Discussion

It is anticipated that the assembly of this design criteria document will be undertaken over the period that the designs of the dam, spillway and power plant are developed, and that this document will provide the foundation of the design program in work subsequent to the license applications.

(d) Level of Effort

Task Force (Acres) $66,000

(e) Schedule

Weeks 80 through 95

Subtask 6.10 - Establish Design Criteria for the Devil Canyon Development

(a) Objective

To establish preliminary design criteria for the Devil Canyon hydroelectric development.

(b) Approach

Documentation of the following criteria related to the design of the Watana development will be initiated in this subtask:

- Hydraulic:
  - reservoir levels
  - storage volumes
  - rule curves
  - power flows
- Geotechnical:
  - foundation conditions
  - foundation treatment requirements
  - construction materials properties
  - seismic design conditions
  - slope stability requirement, soil and rock
- Structural:
  - loading conditions
  - uplift pressures
  - wind loads
  - temperature conditions and loads
  - material design properties
  - stability analysis procedures
- Mechanical:
  - turbine design requirements
  - power plant mechanical systems
  - gate design requirements
  - crane design requirements
- Electrical:
  - generator design requirements
  - power plant electrical systems
  - transmission requirements
  - ancillary electrical equipment requirements
- General:
  - design codes and standards
  - special Alaska or site-related requirements
  - transportation limitations
  - ice conditions

(c) Discussion

It is anticipated that the assembly of this design criteria document will be undertaken over the period that the designs of the dam, spillway and power plant are developed, and that this document will provide the foundation of the design program in work subsequent to the license applications.

(d) Level of Effort

Task Force (Acres) $57,000

(e) Schedule

Weeks 80 through 95

Subtask 6.11 - Preliminary Design of Watana Dam

(a) Objective

To prepare the preliminary design and associated cost estimate and construction schedule for the Watana Dam.

(b) Approach

This subtask will be initiated once the preliminary study of alternative dam sections, undertaken in Subtask 6.08, has been completed and approved. The primary input to this subtask, once the type of dam has been established, will be the results of the field investigations (Task 5) and the seismic studies (Task 4). Cost estimating data will be provided through Task 9. Specific activities to be undertaken will include:

- Assembly and review of most recent field and seismic study data;

- Preparation of a preliminary layout of the dam dimensioned to meet the basic requirements of the project design criteria;

- Development of appropriate preliminary design details, including grouting and pressure relief provisions, foundation and abutment preparation as required by the basic dam design within the context of the geotechnical conditions;

- Preparation of preliminary stability analyses for the critical conditions set out in the preliminary design criteria document (Subtask 6.09). Geotechnical design parameters to be provided on the basis of results obtained from the laboratory tests carried out in Task 5. Specific conditions will depend upon the type of dam selected, but for a rockfill dam with a central core, would typically include:

  -- end of construction conventional slope stability analysis
  -- rapid drawdown conditions utilizing residual pore pressures and conventional stability analysis
  -- maximum W.L. and seismic loads will be evaluated by dynamic analysis utilizing excess pore pressure generation application tests
  -- Stress and deformations will be examined by finite element analysis

- Review and adjustment of design to accommodate anomalies indicated in the course of the stability studies undertaken above

- Reservoir studies, including:

  -- reservoir slope stability assessment in relation to thawing permafrost and generation of high pore pressures
  -- reservoir slope stability during seismic events, including impact on liquefaction-sensitive soils and mass instabilities
  -- snow slide assessment

- Computation of quantities and development of estimate of cost for the dam and associated cofferdams and diversion tunnels

- Development of dam construction schedule

- Preparation of material for input to dam selection report

(c) Discussion

In the development of the dam design, the following key aspects will be taken into account:

(1) Foundation and Abutment Conditions

Study of foundation and abutment conditions will include assessment of the available information on overburden, bedrock, structural geology including identification of local shear zones, faults and joint sets and the consolidation and strength characteristics. Based on the parameters from the assessment, the design will determine foundation seepage, permanent pressure relief, foundation treatment, consolidation and curtain grouting requirements, abutment stability, shaping of abutments, overburden and rock excavation requirements and excavation dewatering. Special considerations will be given to excavation of loose riverbed alluvium, talus materials near abutments.

(2) Construction Materials

Study in detail the availability and suitability of construction materials and their methods of exploitation for earth/rockfill and concrete dams and other associated concrete structures. Various sources of impervious material as well as a rock quarry for rockfill materials and concrete aggregates will be investigated in the field. Evaluation of the field data and laboratory test results will be done to determine the suitability of the construction materials and the parameters to be used in the design. Placing problems of impervious fills due to wet weather and cold climatic conditions will be studied on a preliminary basis. Shear behavior of impervious and shell materials will be studied under dynamic and high-confining stresses.

(3) Seismic Effects

Damages to dams during earthquakes can occur as deformation of the embankment collapses slopes, cracks cores and loosens the soil masses. Conventional methods cannot be employed for anything other than the collapse of slopes. In order to study the other two problems, it will be necessary to study the stresses and deformations produced in embankments at the time of an earthquake. The magnitude of deformations and stresses that develop will depend on the time history of inertia forces induced by the sudden ground displacements during an earthquake. A logical method of design requires:

- a determination of the variation of inertia forces with time
- an assessment of the embankment deformations and stresses induced by these forces.

Simplified numerical techniques which are comparable to dynamic finite element analysis such as the Characteristic Method in combination with other simplified methods, will be used for the seismic analysis.

The ground motion characteristics, the cyclic stress-strain data and the dynamic material properties obtained from Task 4 studies will be utilized in the seismic design of earth/rockfill dams and embankments. The following measures will be included in the design to preclude the possibility of failure or major damage during an earthquake:

- avoidance of major faults in the foundation
- provision of sufficient vertical and horizontal drainage
- provision of ample freeboard
- use of wide transition zones of filter materials which are not vulnerable to cracking
- use of wide cores of materials with self-healing and erosion resistant properties
- appropriate provisions for handling wave effects due to earthquakes or landslides into the reservoir
- provision of appropriate crest details to minimize erosion
- appropriate measures to prevent slope failures or sliding of the dam on its foundations
- construction of well-compacted cofferdams to buttress main section

(4) Permafrost Studies

Permafrost studies will include application of the state-of-the-art in permafrost to the dam design, assessing the data from the field investigations and determining permafrost conditions on foundation and abutments and on the proposed foundation treatment such as grouting.

(5) Dam Sections

The design of dam fill sections will involve study of layouts, zoning arrangements for earth/rock-fill dams, optimization of dam slopes, requirements for filters, drains and slope protection riprap. Detail stability analyses, static and dynamic will be done for various loading conditions such as end of construction, long-term steady seepage and rapid drawdown. Dynamic loading conditions will be studied as mentioned in Section 3 under seismic effects. The design will include settlement and seepage analyses in the fill and foundations and determine the type and scope of instrumentation to measure the performance of the structure.

(6) Construction Sequence and Method

The study will evaluate the effects of construction sequence and methods such as staged construction on cost and schedules. Also, it will determine effects on materials availability, method of placement and design of dam zoning and cofferdams and other river closure procedures. Construction period will be largely influenced by climatic conditions in the project region. This will particularly affect the placing of impervious fills and overall construction time of the structure. The study will include assessing the number of wet days during a construction season and the number of days of freezing in a year that will prohibit placing.

(d) Level of Effort

Task Force (Acres) $120,000

(e) Schedule

Weeks 85 through 110

ACRES

Subtask 6.12 - Preliminary Design of Devil Canyon Dam

(a) Objective

To prepare the preliminary design and associated cost estimate and construction schedule for the Devil Canyon Dam.

(b) Approach

This subtask will be initiated once the preliminary study of alternative dam sections, undertaken in Subtask 6.08, has been completed and approved. The primary input to this subtask, once the type of dam has been established, will be the results of the field investigations (Task 5) and the seismic studies (Task 4). Cost estimating data will be provided through Task 9. Specific activities to be undertaken will include:

- Assembly and review of most recent field and seismic study data;

- Preparation of a preliminary layout of the dam dimensioned to meet the basic requirements of the project design criteria;

- Development of appropriate preliminary design details, including grouting and pressure relief provisions, foundation and abutment preparation as required by the basic dam design within the context of the geotechnical conditions;

- Preparation of preliminary stability analyses for the critical conditions set out in the preliminary design criteria document (Subtask 6.10). Foundation design parameters to be provided on the basis of results obtained from the laboratory tests carried out in Task 5. Specific conditions will, of course, depend upon the type of dam selected, but for a concrete gravity dam would typically include:

  -- conventional stability and sliding analyses and stress distribution on foundation
  -- determination of response of the concrete dam to seismic forces
  -- stress and deformations will be examined by finite element analysis

- For the embankment section stability analyses as discussed in Subtask 6.11 will be performed.

- Review and adjustment of design to accommodate anomalies indicated in the course of the stability studies undertaken above

- Reservoir studies, including:

  -- reservoir slope stability assessment in relation to thawing permafrost and generation of high pore pressures
  -- reservoir slope stability during seismic events, including impact on liquefaction-sensitive soils and mass instabilities
  -- snow slide assessment

- Computation of quantities and development of estimate of cost for the dam and associated cofferdams and diversion tunnels

- Development of dam construction schedule

- Preparation of material for input to dam selection report

(c) Discussion

In the development of the dam design, the following key aspects will be taken into account:

(1) Foundation and Abutment Conditions

Study of foundation and abutment conditions will include assessment of the available information on overburden, bedrock, structural geology including identification of local shear zones, faults and joint sets, and consolidation and strength characteristics. Based on the parameters from the assessment, the design will determine foundation seepage, permanent pressure relief, foundation treatment, consolidation and curtain grouting requirements, abutment stability, shaping of abutments, overburden and rock excavation requirements and excavation dewatering. Special consideration will be given with regard to excavation of loose riverbed alluvium, and talus materials near abutments.

(2) Construction Materials

Study in detail the availability and suitability of construction materials and their methods of exploitation for earth/rockfill and concrete dams and other associated concrete structures. Various sources of impervious material as well as rock quarry for rockfill materials and concrete aggregates will be investigated in the field. Evaluation of the field data and laboratory test results will be done to determine the suitability of the construction materials and their parameters to be used in the design. Placing problems of impervious fills due to wet weather and cold climatic conditions will be studied on a preliminary basis. Shear behavior of impervious and shell materials will be studied under dynamic and high-confining stresses.

(3) Seismic Effects

For the concrete dam, the seismic impact and response will be evaluated by dynamic, finite element techniques commonly adapted for such analyses. Stress concentration and deformation in the body of the dam or at the foundation will be evaluated. Damages to dams during earthquakes can occur as deformation caused by shear failure in the concrete section of the dam.

The seismic effect on the embankment section is discussed in Subtask 6.11 and is not repeated here.

ACRES

(4) Permafrost Studies

Permafrost studies will involve application of the state of the art in permafrost to the dam design. Data from the field investigations will be assessed to determine permafrost conditions in foundation and abutments, and to establish the proposed foundation treatment such as thawing, grouting, etc.

(5) Dam Sections

The design of concrete dam sections will involve study of layouts, jointing pattern and other concrete details,and for the fill dam, zoning arrangements, optimization of dam slopes, requirements for filters, drains and slope protection riprap. Detailed stability analyses, static and dynamic will be done for various loading conditions such as end of construction, long-term steady seepage and rapid drawdown. Dynamic loading conditions will be studied as mentioned in Task 4 under seismic effects. The design will include settlement and seepage analyses in the fill and foundations and will determine the type and scope of instrumentation to measure the performance of the structure.

(6) Construction Sequence and Method

The study will evaluate the effects of construction sequence and methods such as staged construction on cost and schedules. Also, it will determine its effects on materials availability, method of placement and design of dam zoning and cofferdams and other river closure procedures. The construction period will be largely influenced by varying climatic conditions in the project region. Acres is particularly experienced in cold weather construction techniques for large dams. These conditions will most certainly affect the placing of impervious fills and concrete and the overall construction time of the structure. The study will include assessing the number of wet days during a construction season and the number of days of freezing in a year that will prohibit placing.

(d) Level of Effort

Task Force (Acres) $105,000

(e) Schedule

Weeks 85 through 110

Subtask 6.13 - Dam Selection Report

(a) Objective

Prepare a report summarizing the results of the study dealing with the selection and preliminary design of dams and reservoirs for the Susitna Development.

(b) Approach

The primary input to this report will be derived from the preliminary design development studies undertaken under Subtasks 6.11 and 6.12. The report will address the following principal topics for each of the dams considered:

- principal hydraulic, geotechnical and structural design criteria
- selection of type of dam
- geology and foundation conditions
- staged construction considerations
- basic design concept
- stability analyses
- diversion and construction conditions
- construction materials
- reservoir conditions
- construction schedule
- estimate of cost

The report will be submitted in draft form to the Engineering Panel and to APA for review prior to finalization.

(c) Discussion

This report, which will contain major technical input to the license application, will provide a focus not only for the work undertaken in a number of the previous subtasks in Task 6 but also for data developed in other primary tasks such as Tasks 4 - Seismic Studies and Task 5 - Geotechnical Exploration.

(d) Level of Effort

Task Force (Acres)	$33,000
External Review Panel	20,000
Total Subtask 6.13	$53,000

(e) Schedule

Weeks 100 through 115

Subtask 6.14 - Spillway Design Criteria

(a) Objective

To establish the basic spillway and diversion design criteria for the Watana and Devil Canyon dam sites.

(b) Approach

Basic design criteria will be established and reviewed with APA and other State and Federal Agencies. These basic criteria define the accepted degree of risk to flood damage and include:

- Spillway design flood. A design flood hydrograph of a high probability of succeedence such as the 10,000 years flood. The service spillway would be sized to accommodate the flood without the reservoir water level encroaching on the required dry freeboard.

- A catastrophic flood event. Normally specified as the probable maximum flood. The service spillway and, if required, emergency spillways would be designed to pass this flood but reservoir levels would be allowed to rise to dam crest level.

- Spillway cavitation criteria. A specification of the magnitude of design flood hydrograph above which limited cavitation/erosion damage will be accepted.

- Downstream erosion criteria. A specification of the magnitude of design flood above which erosion damage requiring subsequent remedial work will occur downstream.

- Freeboard criteria. A specification of the severity of the climatic and reservoir landslide event for which adequate dry freeboard is required. Climatic events which affect freeboard are high winds and it is usual to specify a design wind velocity having a return period of say 100 years.

- Landslides

  Landslide events due to seismicity or other causes are more difficult to deal with quantitatively. It is also often uneconomic to allow sufficient freeboard to prevent overtopping due to a reservoir slide. On the Mica dam project, in British Columbia this was the case and the reservoir crest was specifically designed to withstand a limited amount of overtopping. We will undertake a brief study to determine the freeboard requirement for such slide events and assess the economic impact of providing adequate freeboard versus protecting the dam crest. Input to this study would be derived for the study outlined in Task 3. Based on the results of this study the required freeboard and crest protection will be recommended.

- Diversion flood criteria. Brief economic studies will be undertaken to determine the economic level of flood protection during the diversion stages . Hydrologic and hydraulic input would be derived from the Task 3 studies and would include open water flood conditions as well as flood levels under ice cover and ice jam conditions.

- Low level outlet criteria. A study would be undertaken to determine the requirement for a low level outlet and, if necessary, the capacity for such an outlet. Aspects that would be considered include:

  -- downstream water quantity and quality requirements

  -- control of reservoir filling rate

  -- requirement for emergency drawdown.

Once these basic criteria are finalized the information would be issued as a design transmittal.

(c) Discussion

The design criteria described above are those usually adapted by Acres for the design of large dams and we recommend them for the Susitna Project.

(d) Level of Effort

Task Force (Acres) $18,000

(e) Schedule

Weeks 70 through 80

Subtask 6.15 - Watana Spillway Alternatives

(a) Objective

Examine alternative potential spillway arrangements for the Watana site, and select the most appropriate for subsequent design development.

(b) Approach

Primary input for this study will be obtained from:

- Task 3 - Hydrology
- Task 5 - Geotechnical Exploration
- Subtask 6.14 - Spillway Design Criteria

Specific activities will include:

- Assembly and assessment of input data
- Preliminary layout of alternative spillway arrangements to meet the requirements set out in the design criteria document within the constraints imposed by the dam and other facilities
- Take-off of quantities and computation of costs of alternative arrangements
- Examination of operational aspects of the spillway alternatives and identification of possible measures required to mitigate adverse effects
- Selection of most appropriate spillway arrangement on the basis of net cost and operational characteristics

(c) Discussion

Having regard to the fact that the energy head to be dissipated in the spillway works at Watana could be as much as 700 feet, and that the safety of the entire development will depend upon the proper operation of the spillway, the selection and subsequent design of this facility will be one of the most critical aspects of the design development program. The selection of the optimum spillway arrangement will depend to a large extent on the ambient economics of the dam and spillway combination, not only in relation to the physical layouts, but also in relation to the potential provision of rockfill for the dam construction from the excavations for the spillway chute.

In the current Corps of Engineers' designs, the spillway chute discharges at right angles to the alignment of the Tsusena Creek, which may be less than attractive from the hydraulic standpoint; however, realignment may prove to be difficult to achieve without involving major excavations. Present indications are that the geology of the left (south) bank is marginally "better" than that of the right bank, and it may be possible to locate an improve orientation on this bank. However, any scheme which involves a shorter and steeper chute will almost certainly require concrete linings to prevent erosion under high velocity flows: this in turn, of course, will involve major additional costs and raises the spectre of cavitation and erosion damages experienced at so many other high-head spillway installations.

The spillway crest control structures will be of essentially conventional concept, designed to accommodate appropriate ice loads/bubbler systems. One or more gates may require heating if spillway operation during freezing weather is required. If alternatives involving steep chutes are considered, then it will be necessary to examine various forms of energy dissipating structures, such as chute blocks, stilling basins, and the like.

(d) Level of Effort

Task Force (Acres) $71,000

(e) Schedule

Weeks 80 through 95

ACRES

Subtask 6.16 - Devil Canyon Spillway Alternatives

(a) Objective

Examine alternative potential spillway arrangements for the Devil Canyon site, and select the most appropriate for subsequent design development.

(b) Approach

Primary input for this study will be obtained from:

- Task 3 - Hydrology
- Task 5 - Geotechnical Exploration
- Subtask 6.14 - Spillway Design Criteria

Specific activities will include:

- Assembly and assessment of input data
- Preliminary layout of alternative spillway arrangements to meet the requirements set out in the design criteria document within the constraints imposed by the dam and other facilities
- Take-off of quantities and computation of costs of alternative arrangements
- Examination of operational aspects of the spillway alternatives and identification of possible measures required to mitigate adverse effects
- Selection of most appropriate spillway arrangement on the basis of net cost and operational characteristics

(c) Discussion

The most recent (1979) Corps of Engineers design for the spillway at Devil Canyon calls for a conventional arrangement discharging over the central section of the concrete gravity dam. For the originally proposed arch dam at this site, the Corps has proposed a ski-jump spillway arrangement discharging at the left abutment of the dam with the lip of the jump some 300 feet above downstream river level.

The ultimately selected arrangement of spillway will, of course, be heavily influenced by the type and arrangement of dam selected, and may in turn affect the selection of the dam. Various aspects influencing the selection of a chute-type spillway arrangement are discussed under Subtask 6.15 above. Design considerations affecting conventional spillway structures are well documented in the literature.

(d) Level of Effort

Task Force (Acres) $65,000

(e) Schedule

Weeks 85 through 95

Subtask 6.17 - Preliminary Design of Watana Spillway

(a) Objective

Design the spillway facilities and associated features for the Watana project.

(b) Approach

From the studies in Subtasks 6.14 and 6.15, the information on spillway design criteria and most suitable locations will be available to develop this subtask. We will critically review foundation conditions of the site and examine previously generated data for the project. Design tasks will include:

- Foundation design of the spillway, ogee section, piers, spillway channel and the chute structure including rock excavation, rock reinforcement, concrete dental work and pressure relief facilities.

- Hydraulic design to determine optimum gate dimensions and gate operating procedures. Development of a spillway operating rule curve based on headwater elevations in the reservoir and gate opening, detailed tailwater curve data and hydraulic profiles to satisfy all operating conditions expected at the project. Determination of the shape and height of piers, walls and chute block.

- Structural details and design of bridge, piers, gates, stoplogs, spillway channel walls and slab chute structures considering normal maximum headwater conditions, and seismic and extreme weather conditions.

- Design of gate facilities to operate under extreme weather and ice conditions. Both bubble formations and heating of necessary elements will be considered for the purpose of adequate cost provision in the estimate.

- Preliminary hydraulic and structural analyses of size, shape, and thrust requirements of the chute block; shape and trajectory of the jet under various flow and tailwater conditions will be reviewed to develop satisfactory solutions. Preliminary study of jet impact will be made and data will be developed for hydraulic modelling of the facilities.

- Appropriate arrangement and design of electrical/mechanical facilities for hoist operation under all conditions including emergency conditions will be developed.

- Safety of the spillway structure as an independent unit and as an integral part of the overall project will be checked.

- If the dam is an embankment structure adjacent to the spillway, the retaining walls will be designed and hydraulic approach conditions will be reviewed.

(c) Discussion

The review of flood routing studies for project design flood, probable maximum flood and other floods generated from Task 3 will provide data on the rule curve for operations of the spillway facility. Gate operation procedures will be developed to suit all flood conditions expected at the site. Flood rule curve data will provide relationships of gate opening and headwater elevation in the reservoir without topping the structure. Hydraulic profiles of the spillway channel will be determined from the gate and size and type of chute will be designed to perform satisfactorily in all conditions with minimum environmental impact and consideration for safety of the dam and reservoir.

(d) Level of Effort

Task Force (Acres) $86,000

(e) Schedule

Weeks 90 through 115

Subtask 6.18 - Preliminary Design Devil Canyon Spillway

(a) Objective

Design spillway facilities and associated features for the Devil Canyon Project.

(b) Approach

This subtask involves critical review of the recommended arrangement of the spillway and design having regard to foundation conditions, location of the spillway and design project features compatible to these conditions. Design will include:

- Foundation design of the spillway, ogee section, channel and the chute structures will include rock excavation, rock reinforcement, concrete dental work and pressure relief facilities.

- Hydraulic design will define gate operating procedures and spillway operating curve based on the relationship of headwater surface elevation and gate opening. Preliminary hydraulic profile for variable flow will define the height and size of the piers, walks and geometery and configuration of ogee section and the chute block.

- In case a concrete gravity dam is selected at Devil Canyon, several kinds of energy dissipation structures will be evaluated including ski jump, stilling basin and chute types and preliminary design will be made of the most suitable facility recommended for the project. In case an arch dam is recommended for the Devil Canyon project site a plunge pool-type facility would be the most suitable arrangement.

- Structural details and design will be drawn up for bridges, piers, gates, stoplogs, spillway channel walls and slab chute structures, considering seismic and extreme weather conditions imposed on the site.

- Design will include provision in the facilities for gate operation under ice conditions and extreme low temperatures and provision will be made for heating certain facilities for satisfactory performance of gates, hoists and guides.

- Hydraulic analyses will determine configuration of the chute and its hydraulic performance including impact tragectory of the jet for various flows and pressure determination near the chute. Data will be developed for a hydraulic model testing program.

- Design will consider electrical and mechanical facilities for power hoist operation of gates under all weather conditions.

- The geometry and the trajectory of the jet and its impact on landing soil will be evaluated. Hydraulic model data will be developed for testing in the later phases of the detailed design of the project.

(c) Discussion

Energy dissipation of about 600 feet head at the Devil Canyon site makes the spillway structure very significant. Dispersion of waves from the flood regulated releases of the upstream Watana dam will need careful evaluation of its impact on the valley walls.

Extreme weather conditions at the project site will require special design consideration during the preliminary stage. Preliminary drawings from which quantities will be taken off will be prepared. The design will be accompanied by the associated schedule and cost estimate including impact on associated structures. The design will be compatible with the hydraulic requirements and will conform with the technical, economic and safety standards.

(d) Level of Effort

Task Force (Acres) $82,000

(e) Schedule

Weeks 95 through 115

Subtask 6.19 - Spillway Selection Report

(a) Objective

Prepare a report presenting the results of studies of alternative spillway design concepts for the Watana and Devil Canyon Sites and the selection and development of preliminary designs in each case.

(b) Approach

The spillway selection report will be assembled to document the results of Subtask 6.14 through 6.18 dealing with consideration of alternatives and preparation of preliminary designs for the Watana and Devil Canyon Spillways. Primary input to the report will be provided by memoranda prepared during the course of those studies to summarize the work undertaken, together with appropriate drawings, cost estimates and schedules.

Specific topics to be addressed in the report will include:

- basis of design flood analysis
- selected design floods
- selected spillway capacity
- selection of spillway type
- selection of discharge facilities
- flood routing analysis
- alternative spillway locations
- preliminary hydraulic design and rating curves
- optimization of crest widths/elevations
- downstream erosion control
- preliminary structural designs
- preliminary stability analysis
- foundation treatment
- construction cost and schedule summaries
- flood control and operational safety
- icing considerations

(c) Discussion

The report will also include a review of the interrelationship of the two reservoirs during floods and the advantages and disadvantages of adopting remote control operation. The technical, economic and environmental issues involved in the selected designs will be discussed together with recommendations for further studies to be undertaken prior to construction, including hydraulic modelling. Discussions will also be presented on equipment contract packaging alternatives.

The report will provide basic input to final design of spillway structures, including structural and hydraulic analyses, geotechnical conditions and hydraulic design of the spillways. The report will also address other problems needing further investigation for the detailed design such as geotechnical design, ice jamming conditions and constraints, seismic loading, possible requirements for heating and other construction problems in extreme climatic conditions.

(d) Level of Effort

Task Force (Acres)	$36,600
External Review Panel	10,000
Total Subtask 6.19	$46,600

(e) Schedule

Weeks 110 through 120

Subtask 6.20 - Access and Camp Facilities

(a) Objective

Develop preliminary designs, arrangement drawings and cost estimates for permanent camp and access road facilities for construction and operation of the Devil Canyon, Watana and related project facilities.

(b) Approach

The results of access road route selection studies, surveys undertaken in Task 2, and geotechnical exploration in Task 5 will provide basic input to this task. The initial camp facilities also developed under Task 2 will provide the basis upon which the camp designs will be developed.

Ongoing Task 6 design activities together with Task 9 construction and resource scheduling input will also be used in the development of camp design.

Preliminary alignment profiles for roads and associated horizontal and vertical curve design criteria will be developed. Road width, loading criteria and data will be based on the heaviest and largest items of power plant equipment to be shipped to the site.

Preliminary plans and profiles will define cut and fill slopes based on geotechnical data and include designs for culverts and bridges. Bridge and culvert alignments and designs will be based on preliminary topographic, geologic and hydrologic input at each location. Tunnels may be used where appropriate. A total of 27 miles of access road to the Devil Canyon site from the area of Highway No. 3 or railroad close to Gold Creek, are envisioned. An additional 37 miles of road will be required from the Devil Canyon site to the Watana site. Access roads will also be required to the air strip to each power plant and other power facilities and to the dam and spillway for each site.

(c) Discussion

Permits required for construction of access roads and camp facilities will be obtained by CIRI/H&N, who will also provide support in the development of camp designs.

Access road and permanent camp facilities will probablv be required at each of the damsites. At least one permanent camp facility with all-weather road access to all permanent installations will also be necessary to support project operation and maintenance.

Permanent camp facilities will include permanent housing and recreation, medical and shopping facilities. This work will form the basis of permitting and contract documents for access roads scheduled to be constructed between 1982 and the end of 1987.

(d) Level of Effort

Task Force (Acres)		$ 61,000
Task Force (R&M)	) Included in	--
Task Force (CIRI/H&N)	) Task 2	--
Total Subtask 6.20		$ 61,000

(e) Schedule

Weeks 70 through 80

Subtask 6.21 - Watana Diversion Schemes

(a) Objective

Examine alternatives and select a river diversion plan to satisfy the construction schedule requirements for construction of the Watana dam, outlet works, spillway, power plant and reservoir, and prepare conceptual designs, drawings and cost estimates for the selected scheme.

(b) Approach

The Watana diversion scheme will depend to a large extent on the type and size of dam selected for the ultimate development and for any intermediate stages of construction.

For a large earth- or rockfill dam of the size currently proposed at Watana, the diversion scheme will comprise some combination of upstream and downstream cofferdams and an appropriate arrangement of tunnels, intakes and outlet structures to divert the flow. Consideration will also be given to alternatives involving channel diversion schemes in the riverbed area during a portion of the construction period. For possible concrete dam alternatives considered under Subtask 6.07, somewhat different design concepts will be involved. These would most likely include diversion of river flow directly through or over partially completed dam structural elements.

Activities undertaken in this subtask will include:

- Selection of diversion design flood and development of other design criteria;
- Study of alternative cofferdam design concepts, heights and placement methods
- Study of alternative tunnel alignments, sizes, methods of construction and lining requirements
- Review of requirements for flow control and conceptual design of intake and outlet structures
- Consideration of icing problems upstream and downstream of the damsite area
- Review of foundation cut-off and treatment requirements
- Consideration of requirements for dewatering of dam foundations
- Evaluation of methods of tunnel closure for reservoir impoundment
- Conceptual designs, drawings and cost estimates for the selected diversion scheme
- Diversion flood routing analyses.

(c) Discussion

The selected scheme will provide safe arrangements for dam construction at minimum cost. Consideration will be given to utilization of permanent project features such as power and tailrace tunnels as diversion facilities.

Input to this subtask will include the proposed dam construction schedule, diversion flood flow criteria, geotechnical exploration data and the type and location of the main dam and associated features. Diversion flood hydrographs and tailwater rating curves for these studies will be based on Task 3 output. The flood hydrograph data will be reviewed and selected for consistence with the risks associated with construction of the Watana dam. Diversion studies will determine the height of the upstream and downstream cofferdams with associated sizes of the diversion tunnel selected for the scheme. These studies will be used to determine an economical combination of size of the diversion tunnel and the cofferdam height.

The severe weather conditions at this site and the imposed restrictions on the construction schedule associated with the relatively well defined seasonal flow variations of the river will impose certain limitations on development of the design of the diversion scheme.

The crest elevation of the upstream diversion dam proposed in the Corps of Engineers 1979 report is about 100 feet above the existing river bed. The embankment of this cofferdam therefore appears to be founded on about 50 feet of gravel and other pervious materials. Construction of the embankment of the diversion dam itself is thus a major task and would probably require its own smaller cofferdam. A slurry trench or cut-off arrangement will probably be required to limit seepage.

Diversion dewatering problems under the core of the main dam will be aggravated because of the required excavation and removal of more than 50 feet of riverbed material.

(d) Level of Effort

Task Force (Acres) $56,000

(e) Schedule

Weeks 85 to 95

Subtask 6.22 - Devil Canyon Diversion Schemes

(a) Objective

Examine alternatives and select a river diversion plan to satisfy the construction schedule requirements for construction of the Devil Canyon dam, outlet works, spillway, power plant and reservoir, and prepare conceptual designs, drawings and cost estimates for the selected scheme.

(b) Approach

The Devil Canyon diversion scheme will depend to a large extent on the type and size of dam selected for the ultimate development and for any intermediate stages of construction. The scheme will also be greatly influenced by the pattern of releases from the upstream Watana development which will probably already be in place.

For a concrete dam of the size currently proposed at Devil Canyon, the diversion scheme will probably comprise some combination of upstream and downstream cofferdams and an appropriate arrangement of tunnels, intakes and outlet structures to divert the flow. Consideration will also be given to alternatives involving diversion of river flow directly through or over partially completed dam structural elements during at least a portion of the construction period. For possible rockfill dam alternatives considered under Subtask 6.08, somewhat different design concepts will be involved.

Activities undertaken in this subtask will include:

- Selection of diversion design flood based on Watana releases and development of other design criteria;
- Study of alternative cofferdam design concepts, heights and placement methods
- Study of alternative tunnel alignments, sizes, methods of construction and lining requirements
- Diversion flood routing studies
- Review of requirements for flow control and conceptual design of intake and outlet structures
- Consideration of icing problems upstream and downstream of the damsite area
- Review of foundation cut-off and treatment requirements
- Consideration of requirements for dewatering of dam foundations
- Evaluation of methods of tunnel closure for reservoir impoundment

- Conceptual designs, drawings and cost estimates for the selected diversion scheme

- Consideration of concrete dam construction methods and risks involved in diversion of river flow through partially completed elements.

(c) Discussion

The selected scheme provide safe arrangements for dam construction at minimum cost. Consideration will be given to utilization of permanent project features such as tunnels, power and tailrace as diversion facilities.

Construction planning and design of diversion facilities will take due account of these factors.

During spring and early summer, discharges from Watana spillway could impose severe limitations and design constraints for the development of the diversion plan for the Devil Canyon site.

Input to this subtask will include the proposed dam construction schedule, appropriate flood flow criteria, geotechnical exploration data and the type and location of the main dam and associated features. If appropriate, diversion studies will determine the height of the upstream and downstream cofferdams with associated sizes of the diversion tunnel selected for the scheme. These studies will also determine a reasonably economical combination of size of the diversion tunnel and the cofferdam height. Tailwater rating curves for these studies will be based on Task 3 output. The flood hydrograph data will be reviewed for its application and appropriately modified in accordance with the risks associated with such a high dam.

(d) Level of Effort

Task Force (Acres) $63,000

(e) Schedule

Weeks 85 to 95

Subtask 6.23 - Optimize Watana Power Development

(a) Objective

Study alternative Watana power plant locations, types and sizes, and associated intake, power conduit and outlet facilities within the context of selected dam and spillway arrangements, and select the optimum power development concept.

(b) Approach

The three major components of project cost at Watana are the dam, the spillway and the power development facilities. To this point in Task 6 studies, work will have concentrated on establishing the requirements for feasible optimum dam and spillway design concepts. These studies will generally have been developed on the basis of engineering judgement and experience and previous report data. This will not detract from the overall objective of this POS in that the further improvements and economies which may be made in the design of the power facilities are not likely to significantly affect the overall technical and economic feasibility of the project.

The location, type and size of the power plant associated with the selected dam and spillway structures will be considered in more detail. The installed capacity and annual generation data developed under Subtask 6.03 will be re-examined in the light of updated total project cost and any additional hydrological data which may have been developed. Additional available geotechnical data will also be a factor in consideration of alternative power plant locations and re-evaluation of power development costs.

Factors to be considered include:

- Confirmation of tailwater rating curves and hydraulic head computations
- Determination of optimum plant capacity and energy outputs as part of the Railbelt Region power system
- Surface and underground, left or right abutment, powerhouse locations
- Number, size and lining requirements for penstocks, tailrace tunnels and surge tank
- Number, type, size and setting of units
- Location and number of transformers
- Switchyard and cabling requirements

Selection of the optimum power development will be on the basis of technical feasibility and safety at minimum cost.

(c) Discussion

The optimum scheduling of hydroelectric installions developed under Task 1 will be reviewed as input to this Subtask.

For the head and size of unit contemplated at Watana, vertical Francis units directly connected to synchronous generators are the most likely installation. Depending on the desired staging of development, modern trends generally suggest that fewer, larger units are most likely to provide maximum opportunities for economy of scale. Discussions will be held with manufacturers in determining the probable optimum size of unit. No problems are anticipated in selecting units at the size and head envisaged. A summary of recent large Francis unit designs is presented in Table A5.5.

The 1979 Corps of Engineers design for Watana indicates an underground power plant location. The scheduling advantages of such an installation are considerable in that year-round construction is facilitated. Nevertheless, surface alternatives may offer some advantages particularly in some of the possible limitations imposed by spillway location priorities.

(d) Level of Effort

Task Force (Acres) $85,000

Schedule

Weeks 90 through 110

TABLE A5.5

TYPICAL LARGE FRANCIS UNITS

Plant	Location	No. of Units	Unit Output	Head	Year in Operation
Churchill Falls	Canada	11	480 MW	1025 ft	1972
Grand Coulee III	Wash., USA	6	3 - 600 MW 3 - 700 MW	285 ft	1977
Guri	Venezula	10	650 MW	380 ft	UC
Itaipu	Brazil	18	780 MW	388 ft	UC
Ludington*	USA	6	343 MW	361 ft	1973
Bath County*	USA	6	357 MW	1079 ft	UC
Mica	Canada	4	625 MW	600 ft	1977
Cobora Bassa	Mozambique	5	484 MW	372 ft	1977
Pauld Alfonso	Brazil	5	425 MW	369 ft	UC

* Francis Reversible Pump-Turbines
UC - Under Construction

Subtask 6.24 - Optimize Devil Canyon Power Development

(a) Objective

Study alternative Devil Canyon power plant locations, types and sizes, and associated intake, power conduit and outlet facilities, within the context of selected dam and spillway arrangements, and select the optimum power development concept.

(b) Approach

As in the case of the Watana site (Subtask 6.23), Task 6 studies will initially have been concentrated on establishing the requirements for feasible optimum dam and spillway design concepts at Devil Canyon.

The location, type and size of the power plant associated with the selected dam and spillway structures will be considered in more detail. However, space restrictions in the narrow Devil Canyon will impose constraints on available powerhouse locations. The installed capacity and annual generation data developed under Subtask 6.03 will be re-examined in the light of updated total project cost and any additional hydrological data which may have been developed. Additional available geotechnical data will also be a factor in consideration of alternative power plant locations and re-evaluation of power development costs.

Factors to be considered include:

- Impact of time release patterns from Watana
- Confirmation of tailwater rating curves and hydraulic head computations
- Determination of optimum plant capacity and energy outputs as part the Railbelt Region power system
- Surface and underground, left or right abutment, or integral dam powerhouse locations
- Number, size and lining requirements for penstocks, tailrace tunnels and surge tank (if required)
- Number, type, size and setting of units
- Location and number of transformers
- Switchyard and cabling requirements

Selection of the optimum power development will be on the basis of technical feasibility and safety at minimum cost.

(c) Discussion

The optimum Devil Canyon power development will be significantly influenced by Watana plant operations.

As at Watana, for the head and size of unit contemplated at Devil Canyon, vertical Francis units directly connected to synchronous generations are the most likely installation. Discussions will again be held with manufacturers in determining the probable optimum size of unit.

The 1979 Corps of Engineers design for Devil Canyon also indicates an underground power plant location. The scheduling advantages of such an installation are considerable in that year-round construction is facilitated. Nevertheless, surface alternatives may offer some cost advantages, particularly if a power plant constructed integrally with the dam proves to be feasible.

(d) Level of Effort

Task Force (Acres)................$83,000

(e) Schedule

Weeks 90 through 110

ACRES

Subtask 6.25 - Optimize Dam Heights

(a) Objective

Consider alternative heights of selected Devil Canyon and Watana dam structures and associated development design concepts and select the optimum.

(b) Approach

At this point in the study the opportunity will be taken to reassess the costs and benefits of each development to confirm or modify the design concepts previously adopted. The Subtask will essentially be undertaken on the basis of the results of previous Task 6 studies of the dams, spillways and power developments. The following activities will be included:

- develop preliminary conceptual designs for alternative dam heights with associated spillway and power development modifications

- re-evaluate development construction costs, power and energy outputs and system economics incorporating the modified development

- select the optimum development concept

- if necessary, make appropriate modifications to conceptual designs and cost estimates of dams and spillways

(c) Discussion

This will essentially be the final step in the determination of project feasibility and in selection of the optimum development at each site in terms of maximized net benefits. In selecting the optimum development due consideration of relevant environmental issues will be taken into account.

(d) Level of Effort

Task Force (Acres) $27,500

(e) Schedule

Weeks 105 to 115

Subtask 6.26 - Preliminary Design Watana Power Development

(a) Objective

Develop preliminary conceptual designs, drawings and cost estimates for Watana power plant, intake, power conduits and outlet works.

(b) Approach

Preliminary designs, drawings and cost estimates will be prepared for the selected optimum power development facilities at Watana including:

- General arrangement
- Powerhouse arrangement
- Valve chambers
- Powerhouse crane
- Access and control room facilities
- Transformer area
- Draft tubes and gates
- Bus ducts and cable shafts
- Intakes and gates
- Penstocks and surge tank (if required)
- Tailrace and outlet structure
- Switchyard and transmission arrangements

The work will also include the following activities:

- Establish the turbine head and capacity rating and mechanical equipment required

- Establish the generator rating and other electrical equipment requirements

- Arrangement of mechanical and electrical equipment in the powerhouse layout for the most efficient use of space

- Preparation of electrical single-line diagram

- Preliminary analyses of transient pressures in the power conduit

- Preliminary penstock steel/concrete lining designs

(c) Discussion

Studies will be made of the geotechnical aspects of the underground structures such as the powerhouse, tunnels and penstocks, with appropriate input from exploratory work. The assessment of geotechnical problems and the design analysis will be sufficient in depth to establish technical feasibility and to determine realistic capital cost and schedule requirements. The essential objective of these studies will be to locate a structurally sound block of rock within which the major openings may be sited with confidence.

As an extension of the field program, the assessment will include rock quality studies identifying and evaluating significant geological features such as faults, foliation, shear zones, principal joint systems, groundwater and seepage regimes. During this process, basic design parameters such as shear strength and rock modulus will be evaluated. Based on assessment and evaluation of the studies, the basic design criteria for rock excavation, rock reinforcement, rock support lining requirements and pressure relief systems for major openings to ensure rock mass stability will be confirmed.

The size of major openings such as the underground powerhouse will be largely dictated by mechanical and electrical equipment, hydraulic requirements, and orientation and shape of the openings. The design optimization of the geometry will depend on the strength characteristics of the mass rock relative to the stresses that may be imposed. Finite element stress analysis may be necessary during later project design phases after submission of the license application to check the stability of the openings.

Ice jamming conditions and other severe weather construction and post-construction conditions will be examined to provide a facility which is fully integrated with the hydraulic system of the conduits and power plant, and can serve under all weather conditions.

Preliminary concepts will be developed for structural details, and concrete pour and jointing details, and consideration of construction methods. To cope with water quality and environmental problems due to reservoir stratification, the intake structure should be capable of drawing water from several different levels. The conceptual design of an intake structure with various levels of withdrawal, power inlet transitions, emergency gates, and trashrack details will be undertaken. Information obtained from manufacturers for specific mechanical and electrical equipment items with associated costs and characteristics will be used in the conceptual layout drawings and also for the cost estimats.

Preliminary conceptual designs of gates, bridges, energy dissipating structures, tunnels and all other hydraulic structures will be made to provide reliable cost data.

(d) <u>Level of Efort</u>

Task Force (Acres) $95,000

(e) <u>Schedule</u>

Weeks 95 to 115

Subtask 6.27 - Preliminary Design Devil Canyon Power Development

(a) Objective

Develop preliminary conceptual designs, drawings and cost estimates for Devil Canyon power plant, intake, power conduits and outlet works.

(b) Approach

As for the Watana Power Development, work under this Subtask will include preliminary designs, drawings and cost estimates for the selected optimum power development facilities at Devil Canyon. These will include:

- General arrangement
- Powerhouse arrangement
- Valve chambers
- Powerhouse crane
- Access and control room facilities
- Powerhouse crane
- Transformer area
- Draft tubes and gates
- Bus ducts and cable shafts
- Intakes and gates
- Penstocks and surge tank (if required)
- Tailrace and outlet structure
- Switchyard and transmission arrangements

The work will also include the following activities:

- Establish the turbine head and capacity rating and mechanical equipment required

- Establish the generator rating and other electrical equipment requirements

- Arrangement of mechanical and electrical equipment in the powerhouse layout for the most efficient use of space

- Preparation of electrical single-line diagram

- Preliminary analyses of transient pressures in the power conduit

- Preliminary penstock steel/concrete lining designs

(c) Discussion

As for Watana, the geotechnical aspects of the design of underground structures such as the powerhouse, tunnels and penstocks will be carefully assessed with due consideration of the results of exploratory work. The assessment of geotechnical problems and the design analysis will be sufficient in depth to establish technical feasibility and to determine realistic capital cost and schedule requirements.

The assessment will include identification of design parameters such as shear strength and rock modulus and evaluation of significant geologic features such as faults, foliation, shear zones, principal joint systems, groundwater and seepage regimes. The basic design criteria for rock excavation, rock reinforcement, rock support lining requirements and pressure relief systems for major openings to ensure rock mass stability will be confirmed.

The size of major openings such as the underground powerhouse will be largely dictated by mechanical and electrical equipment, hydraulic requirements, and orientation and shape of the openings. Finite element stress analysis may be necessary during later project design phases after submission of the license application to check the stability of the openings.

Evaluation of the impact of conjunctive operation of Devil Canyon and Watana will be undertaken, including the effects of ice jamming and other severe weather construction and post-construction conditions.

To cope with water quality and environmental problems due to reservoir stratification, the intake structure should be capable of drawing water from several different levels. The conceptual design of an intake structure with various levels of withdrawal, power inlet transitions, emergency gates, and trashrack details will be undertaken. Information obtained from manufacturers for specific mechanical and electrical equipment items with associated costs and characteristics will be used in the conceptual layout drawings and also for the cost estimats.

Preliminary conceptual designs of gates, bridges, energy dissipating structures, tunnels and all other hydraulic structures will be made to provide reliable cost data.

(d) Level of Efort

Task Force (Acres) $93,000

(e) Schedule

Weeks 95 to 115

Subtask 6.28 - Power Development Report

(a) Objective

Prepare a report presenting the results of studies of optimization of power development alternatives for the Watana and Devil Canyon Sites and the selection and development of preliminary conceptual designs in each case.

(b) Approach

The power development report will be assembled to document the results of Subtasks 6.06 and 6.23 through 6.27. The report will deal with consideration of alternatives and preparation of preliminary designs for the Watana and Devil Canyon power developments, including intakes, penstocks, surge tanks, power plants, tailrace, switchyard and transmission facilities for each site. Primary input to the report will be provided by memoranda prepared during the course of those studies to summarize the work undertaken, together with appropriate drawings, cost estimates and schedules.

Specific topics to be addressed in the report will include:

- staged power development considerations
- selection of generating capacity of installations
- geotechnical design considerations
- hydraulic design parameters
- conceptual design of power developments
- single-line diagrams
- cost estimates and schedules
- mechanical equipment selection
- electrical equipment selection
- accessory electrical equipment
- miscellaneous power plant equipment

(c) Discussion

The technical and economic issues involved in the selected designs will be discussed together with recommendations for further studies to be undertaken prior to construction. At least one of the power plants will incorporate an underground cavern installation. The selection of location and geologic considerations for the underground facilities will be fully discussed. Recommendations will also be presented for equipment and construction contract packaging alternatives to be considered.

The report will provide basic input to final design of power development structures, including structural and hydraulic analyses, geotechnical conditions and hydraulic design of the intake, penstock and tailrace facilities. The report will also address other problems needing further investigation for the detailed design such as geotechnical design, ice jamming conditions and constraints, seismic loading, possible requirements for heating and other construction problems in extreme climatic conditions.

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(d) Level of Effort

Task Force (Acres)	$19,600
EXternal Review Panel	$10,000
Total Subtask 6.19	$29,600

(e) Schedule

Weeks 110 through 120

Subtask 6.29 - Watana General Arrangement

(a) Objective

Prepare general arrangement drawings for the Watana development for inclusion in the FERC license application.

(b) Approach

In this subtask the complete general arrangement of the Watana dam project will be developed. These arrangements will be based on preliminary designs prepared under preceding Task 6 activities for the major project components, including:

- reservoir area
- dam and access facilities
- spillway control structure and access facilities
- spillway discharge facilities
- intake structure and access facilities
- power plant and access facilities
- penstocks and surge tank (if required)
- tailrace arrangement
- switchyard and transmission facilities
- site access and camp facilities

The arrangement will be prepared in the form of reservoir and damsite area layout drawings appropriate for inclusion in the FERC license application.

(c) Level of Effort

Task Force (Acres) $60,000

(d) Schedule

Weeks 110 to 120

ACRES

Subtask 6.30 - Devil Canyon General Arrangement

(a) Objective

Prepare general arrangement drawings for the Devil Canyon development for inclusion in the FERC license application.

(b) Approach

In this subtask the complete general arrangement of the Devil Canyon project will be developed. These arrangements will be based on preliminary designs prepared under preceding Task 6 activities for the major project components, including:

- reservoir area
- dam and access facilities
- spillway control structure and access facilities
- spillway discharge facilities
- intake structure and access facilities
- power plant and access facilities
- penstocks and surge tank (if required)
- tailrace arrangement
- switchyard and transmission facilities
- site access and camp facilities

The arrangement will be prepared in the form of reservoir and damsite area layout drawings appropriate for inclusion in the FERC license application.

(c) Level of Effort

Task Force (Acres) $58,000

(d) Schedule

Weeks 110 to 120

Subtask 6.31 - Project Feasibility Report

(a) Objective

Prepare report documenting the procedures followed in the evaluation of feasibility of the Susitna Hydroelectric Project, including the results of technical and economic studies, conceptual designs, preliminary environmental assessments and recommendations for the future development of the project.

(b) Approach

This report will assemble the results and documentation from all work undertaken in Task 6 and pertinent aspects of all other tasks. Previous reports prepared under Task 6 will be condensed into a single document, including:

- Subtask 6.05 - Development Selection Report
- Subtask 6.13 - Dam Selection Report
- Subtask 6.19 - Spillway Selection Report
- Subtask 6.28 - Power Development Report

The feasibility report will form the basis of the FERC license application and provide Alaska Power Authority with all technical and economic information necessary to decide whether or not, and how to proceed with the project.

Specific topics to be dealt with in the report will include, for each of the Watana and Devil Canyon sites:

- Description of project
- Basic project data
- Design criteria
- Project staged development concepts
- Dam alternatives
- Consideration of Devil Canyon arch dam design
- River diversion schemes
- Spillway alternatives
- Power development alternatives
- Conceptual project designs and drawings
- Cost estimates and schedules
- Transmission
- Construction contract packaging
- Environmental considerations
- Power marketing studies
- Project feasibility assessments
- Recommendations for project development

(c) Discussion

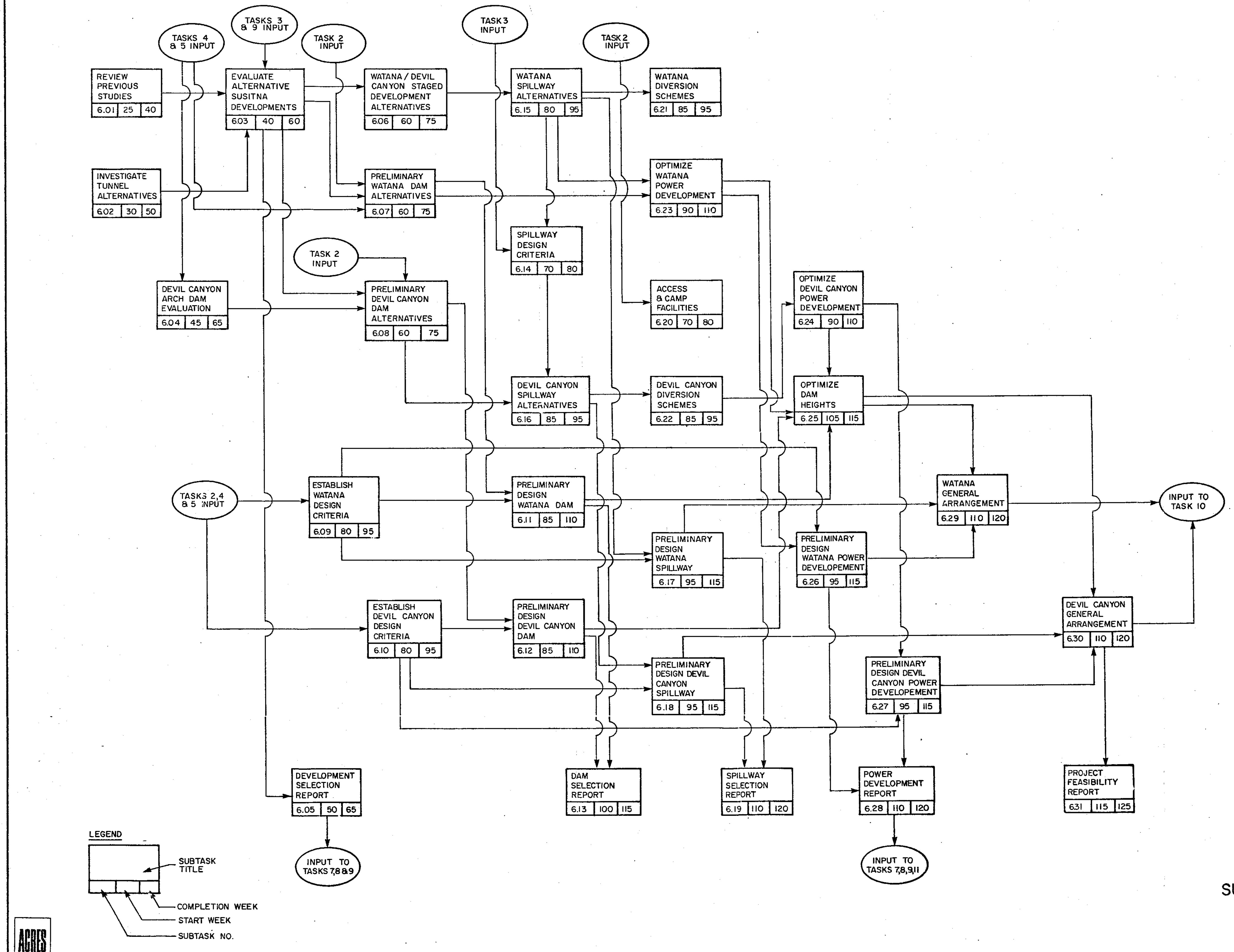
The feasibility report will be submitted for comment by the external review panel and the Alaska Power Authority prior to completion and issue to the public. The report will form the basis of continued development and financing of the Susitna Project to meet the future power needs of the Railbelt Region.

(d) Level of Effort

Task Force (Acres)	$45,000
Review Panel	20,000
Total Subtask 6.31	$65,000

(e) Schedule

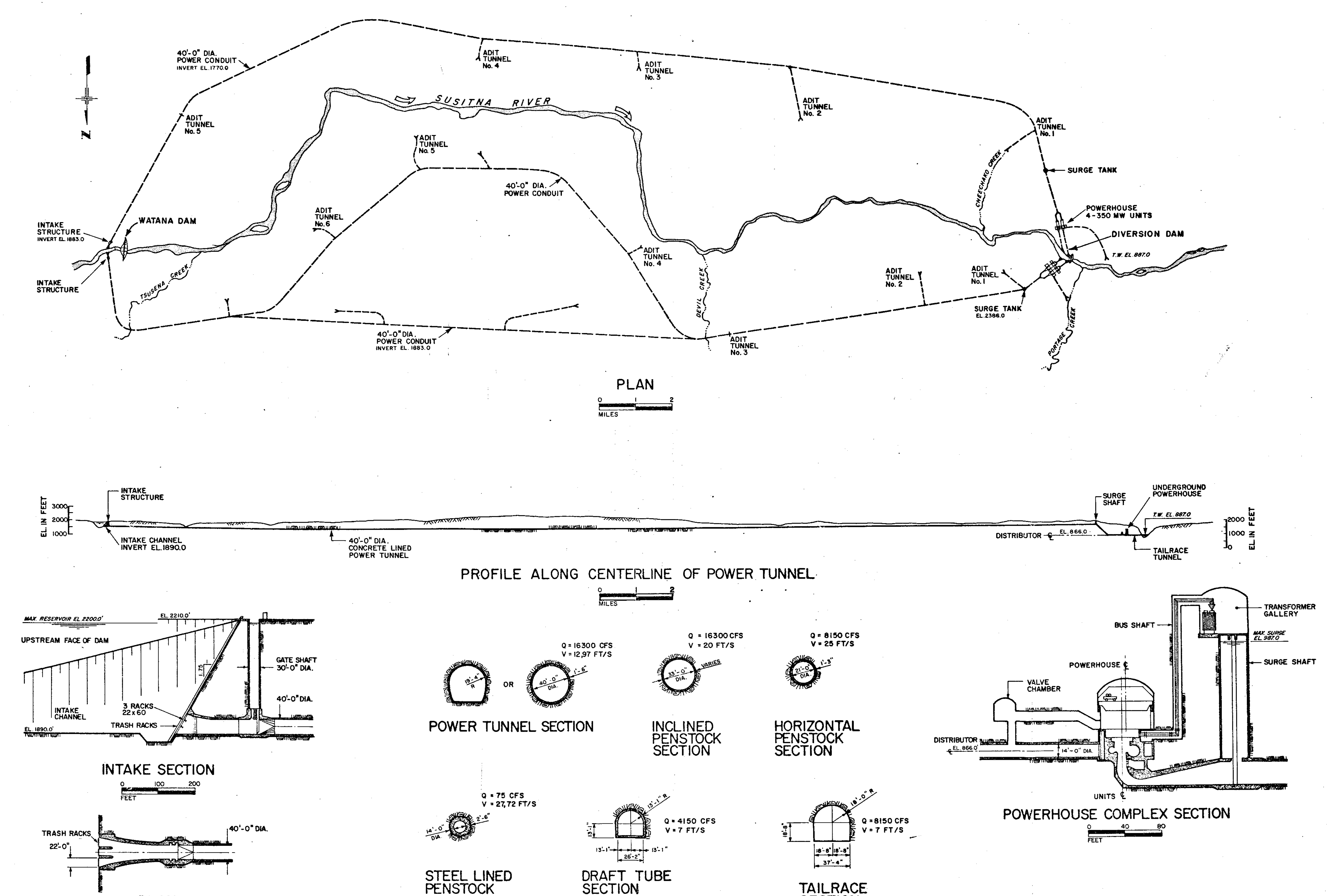
Weeks 115 through 125



SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE T6.1: TASK 6 SCHEDULE



SUSITNA HYDROELECTRIC PROJECT

PLATE T6.2: ALTERNATIVE TUNNEL SCHEMES

TASK 7: ENVIRONMENTAL STUDIES

A.5.8 - TASK 7: ENVIRONMENTAL STUDIES

(i) Task Objectives

The environmental program is designed to evaluate primarily the Susitna Hydroelectric Project and associated facilities, with respect to environmental impacts. To accomplish this, a comprehensive program of studies has been developed in the following disciplines: socioeconomics, archaeological and historical resources, geology, land use and recreation, water resources, fish ecology, wildlife ecology and plant ecology. Access roads, site facilities and transmission corridors will also be studied for environmental compatibility.

The overall objective of the environmental studies is to describe the existing environmental conditions, evaluate alternatives in light of the existing conditions and, for the selected alternatives, predict future conditions with and without the proposed project so that changes (impacts) caused by the project may be assessed. To accomplish this overall objective, the following activities will be completed by the environmental study team:

(a) Assist the design team in selecting the best alternatives for power generation, access road and site facility locations and power transmission corridor based on the environmental impact of the proposed facility.

(b) Prepare the exhibits required to support the FERC license application.

(c) Prepare amendments to the Corps of Engineers' approved EIS for the Susitna Project responding to and eliminating areas of concern or shortcoming in the EIS.

(d) Respond to intervenors' petitions, inquiries from local, state and Federal agencies, and public participants at the request of APA.

(e) Assist APA in obtaining Water Quality Certification.

(f) Respond to other environmental needs of APA or the project engineerng team as they occur throughout the study.

(g) Supervise and coordinate both the field and office activities of all the environmental consultants including liaison with ADF&G as authorized by APA.

(h) Monitor all field activities for environmental acceptability.

During preparation of the FERC license application, intensive baseline and impact-related investigations will be performed with the work progressing from general to specific in a timely manner as the project definition is developed. Because of the magnitude of the proposed action, the life cycle of some of the resources to be studied and the time required to evaluate alternatives and develop design specifications, environmental studies will be required beyond the time of license application. Thus, one objective of the early studies is to initiate baseline studies and to develop detailed plans of study for the further environmental impact analysis that will be completed after the license application submission, but prior to a final FERC decision on the license application.

This approach will allow for a refinement of the environmental program at approximately the midpoint of its duration. It will also minimize unproductive expenditures in the event that the project is determined to be infeasible or a new scheme is proposed as the primary alternative. For the purposes of the environmental plan of study, a two-dam scheme (Watana and Devil Canyon) in the Upper Susitna Basin was assumed to be the best alternative, and studies will commence accordingly. If a different scheme is selected as the primary alternative, the program will need to be restructured and costs and schedule adjusted accordingly.

(ii) Task Output

The Alaska Power Authority will be provided with quarterly progress reports describing in summary the activities, results, and conclusions of the studies in progress or to be performed. Annual reports describing in detail the results and conclusions will be prepared. The annual reports will be used to prepare the environmental exhibit (Exhibit E) for the FERC license application. The pre-license application program is based upon an understanding that the forthcoming revision of FERC requirements (for Exhibit E) will demand less intensive environmental analysis at the license application stage than do the existing requirements for Exhibits W, R, S, and V.

Subsequent study outputs will include written testimony and responses to interrogatories. Oral testimony at public hearings will be provided as required. The results of the studies completed after license application submission, including refinement of the impact analysis, are anticipated to be presented in two annual supplementary environmental reports for submission to FERC.

At the request of the APA, environmental documents necessary to obtain approval of an amended EIS, Water Quality Certifications or other required permits will be prepared.

(iii) List of Subtasks

Subtask 7.01 - Coordination of Environmental Studies
Subtask 7.02 - Monitoring of Field Activities for Environmental Acceptability
Subtask 7.03 - Evaluation of Alternatives
Subtask 7.04 - Water Resources (Quality) Analysis
Subtask 7.05 - Socioeconomic Analysis
Subtask 7.06 - Cultural Resource Investigation
Subtask 7.07 - Land Use Analysis
Subtask 7.08 - Analysis of Recreational Development
Subtask 7.09 - Susitna Transmission Corridor Assessment
Subtask 7.10 - Fish Ecology Baseline Studies and Analysis
Subtask 7.11 - Wildlife Ecology Baseline Studies and Analysis
Subtask 7.12 - Plant Ecology Baseline Studies and Analysis
Subtask 7.13 - Geological Analysis
Subtask 7.14 - Access Road Environmental Analysis
Subtask 7.15 - Preparation of FERC License Application Exhibit

(iv) Subtask Scope Statements

The primary objective of Task 7 is described in Section A.5.8(i). The subtasks required to adequately respond to this objective are divided into activities undertaken prior to submission of the FERC license application, Subtasks 7.1 through 7.15, and those activities on which continuing work is to be performed after submission of the FERC license application, as described in Section A7.

Subtasks 7.1 through 7.14 may be further subdivided into:

(a) Management and monitoring functions that continue throughout the project, Subtasks 7.1 and 7.2.

(b) Those activities initiated and completed prior to license application submission, Subtasks 7.3, 7.4, 7.13 and 7.14.

(c) Those activities for which baseline studies are completed and substantial impact analyses are initiated during the preparation of the license application, Subtasks 7.5 through 7.9. These subtasks are then completed after the license application is submitted to FERC; however, the work effort is less intense than during the pre-license application period.

(d) The ecological studies that require extensive, long-term field programs, and that are planned and initiated during the early stages of the project, Subtasks 7.10 to 7.12. During this early time period, the primary effort is directed toward data collection and compilation with little detailed analysis being undertaken. The data collection is continued after the license application is submitted until the four or five years of data required to form an adequate base is accumulated. An intensive data analysis and impact assessment is then completed. It should be noted that sufficient data analysis will take place during the early time period to guide and follow-up baseline studies and insure that no gaps exist in the data base being compiled.

ACRES

If any deficiencies in an original program plan are detected, the analysis performed during the early time period will be used to modify the plan and redirect the emphasis of the field studies as required.

Subtask 7.15 is the culmination of the early activities, i.e., preparation of Exhibit E of the license application.

The following discussions are summaries of the work to be completed during each of the environmental subtasks. More detailed descriptions of the rationale and study design for the more complex environmental studies (Subtasks 7.05, 7.06, 7.07, 7.08, 7.10, 7.11 and 7.12) are presented in Section C7 - Environmental Appendix.

Subtask 7.01 - Coordination of Environmental Studies

(a) Objective

The objectives of this subtask are:

(1) to ensure that all environmental Plans of Study are executed in a coordinated, controlled manner in accordance both with the scopes of work and compliance schedules;

(2) to coordinate the implementation of all discipline-specific environmental Plans of Study;

(3) to maximize study effort and efficiency through organized inter-discipline coordination in accordance with the subtask responsibility statements;

(4) to ensure that all project efforts are non-duplicative and cost-effective; and

(5) to provide the Alaska Power Authority and third-party interests with a framework for communication on all environmental matters.

(b) Approach

Dr. John W. Hayden, Environmental Division Manager of Acres, and Mr. Jeffery O. Barnes, President of Terrestrial Environmental Specialists will provide management for all environmental studies conducted for the Susitna Project. Mr. Barnes will be responsible for obtaining the services of qualified subcontractors to perform the discipline-specific tasks necessary for the licensing of the project. As the prime contractor, Acres is solely responsible to APA for the cost, schedule and quality of all work; thus, subcontract agreement between TES and their subcontractor shall be submitted to Acres' Project Manager for final review and approval. TES will provide the day to day technical guidance of and coordination among their subcontractors to insure their compliance with both time schedules and cost estimates and to assure technical satisfaction of licensing requirements.

A preliminary environmental studies schedule appears in this Plan of Study. A detailed schedule of all environmental activities will be developed as soon as the relationship between environmental studies to be undertaken by ADF&G, TES and other groups or agencies yet unidentified are known. The final schedule will also be coordinated with the engineering studies to ensure timely input from Tasks 1, 2, 3, 5, 8 and 12. The environmental studies schedule will identify the tasks to be accomplished, the length of time allocated for subtask accomplishment and project milestones. The finalized schedule will be submitted through Acres' Project Manager to APA for review, comment and approval.

Quality control procedures previously utilized by Acres and TES will be implemented to insure the uniformity and accuracy of both the technical and environmental data collected in support of the environmental programs. These procedures will be established and put into effect at the outset of the study and will be rigorously followed throughout the course of study.

The division of responsibilities for the accomplishment of subtask objectives will also be clearly defined at project initiation. Technical, inter- and intra-discipline meetings will be held on a regular basis throughout the study effort to facilitate understanding of subtask duties. Meetings for the purpose of keeping engineering personnel, the APA, and third party interest groups abreast of environmental study activities and findings will also be held on a regularly scheduled basis.

(c) Discussion

Management and administration of the environmental studies shown on Plate A5 will be accomplished through the formulation of a three-tiered management pyramid with the third (or lowest level) being the working level. At the top will be the Environmental Study Managers (ESM) consisting of Dr. Hayden and Mr. Barnes. Next in command will be the Environmental Study Directors (EPD) consisting of the Principal Director, Dr. Vincent J. Lucid, Director of Environmental Studies for TES and the Deputy Director, Ms. Cathie Baumgartner, Vice President of TES. Beneath them appear the team leaders for areas of activities involving more than two disciplines and/or the Principal Investigators.

Administration of environmental studies will be handled by the Environmental Study Managers. They will be responsible for insuring the successful completion and applicability of that portion of the FERC application pertaining to environmental matters. In conducting their duties and responsibilities, they will:

(1) insure the fulfillment of contract requirements;

(2) insure coordination with all technical aspects of the overall study;

(3) conduct liaison with regulatory agencies and interested third parties;

(4) recommend approval/disapproval on all project cost and/or work scope changes to Acres Project Manager;

(5) keep the following personnel and agencies informed of pertinent decision and/or environmental activities:

- Project Manager, Acres
- Appropriate Engineering Group Leaders
- Local, state and federal agencies, as designated by Acres Project Managers, (including APA, ADF&G, USFWS, BLM and ADNR, Corps and others).

(6) provide monthly progress reports to Acres' Project Manager;

(7) approve minor Project Work Scope adjustments with our information copy to Acres' Project Manager; and

(8) review, approve and recommend, release and distribution of reports to Acres' Project Manager.

The Environmental Study Managers will provide direction for the timely initiation of the environmental studies and other project activities on an as-needed rather than a day-to-day basis for maximum study schedule and cost efficiency.

Administration of all day-to-day project activities will be the responsibility of the Environmental Study Directors. Their responsibilities will include, but not be limited to:

(1) developing comprehensive quality control procedures applicable in all phases of the environmental effort;

(2) approving the initiation of all environmental sampling efforts;

(3) providing problem resolution on an as-needed basis;

(4) supervising expenditures and cost-accounting procedures and audit invoices;

(5) providing design recommendations to the Acres' Project Manager, and

(6) reviewing and approving all reports for internal action and transmit final copies to the ESM for appropriate disposition.

The management and administration of all technical programs will be the responsibility of the Environmental Study Directors. However, they may delegate this authority and responsibility to Group Leaders when appropriate. The level of responsibilities include:

(1) insure completeness and effectiveness of discipline-specific studies in meeting study objectives;

(2) provide direction of and assistance with the initiation of all field sampling efforts;

(3) maintain active supervision of project staff efforts on a day-to-day basis;

(4) recommend approval/disapproval of adjustments to discipline-specific studies;

(5) maintain a detailed status report of all discipline-specific studies to insure conformance with program objectives;

(6) approve minor program/sampling procedure adjustments to make the program more compatible with existing conditions;

(7) inform the ESD of program activities on a regularly scheduled basis;

(8) provide design recommendations to ESD.

Principal Investigators (PI) will share some of the duties previously identified as Group Leader responsibilities, especially with respect to the conduct of the field sampling efforts. In addition, each PI will, as a minimum:

(1) recommend modifications to cost and/or discipline-specific study efforts based upon sampling results; and

(2) provide monthly progress and activity status reports either to the Group Leader or the ESD.

Project assignments and an organizational chart for the environmental study team are presented in later sections of this Plan of Study.

The proposed environmental Plan of Study is designed to meet the needs of the Susitna Project license application to FERC and to complete the existing Corps of Engineers EIS for the project. However, flexibility and judgement affecting study details should be reserved for the purpose of matching study efforts to an ever-changing public demand for environmental quality protection and to changing regulatory requirements and attitudes.

(d) Level of Effort

Task Force (TES)	$266,000
Liaison and review (Acres)	49,500
Total Subtask 7.01	$315,500

(e) Schedule

Weeks 1 - 130

Subtask 7.02 - Monitoring of Field Activities for Environmental Acceptability

(a) Objective

The objective of this subtask is to keep the environmental impact of surface disturbing and all other field activities to a minimum.

(b) Approach

Surface disturbing activities of any kind will be monitored by a field representative. This representative will also coordinate certain activities within the environmental discipline and may coordinate activities among groups to avoid conflicts. Of particular concern is the unintentional disturbance of an important archaeological or historical site or an environmentally sensitive area.

(c) Discussion

As the environmental, geotechnical and other study programs are implemented, a certain amount of field sampling and testing will be required. A field representative will be on hand to outline areas that are sensitive to disturbance and also to monitor surface disturbing activity while it is occurring. This monitoring will ensure compliance with existing environmental regulations. In certain instances, mitigation measures will be recommended to reduce impacts.

The field representative will also have a certain amount of coordination responsibilities. This will include coordinating sampling locations of the various groups. Conflicts could arise, for example, if one group plans to clear an area for testing purposes, while another group is in the process of collecting biological data that would be affected by such clearing. Although conflicts may not always be avoidable, the field representative will be responsible for keeping track of present or proposed sampling programs and notifying groups when conflicts may occur.

(d) Level of Effort

Task Force (TES)	$88,000
Liaison and review (Acres)	2,000
Total Subtask 7.02	$90,000

(e) Schedule

Weeks 1 through 130

Subtask 7.03 - Evaluation of Alternatives

(a) Objective

To compare, from an environmental standpoint, the various alternatives for power generation and associated transmission facilities.

(b) Approach

The environmental evaluation of power development alternatives will identify the potential impact issues, and their relative magnitudes, associated with alternative developments. The engineering staff of Acres and WCC will identify and describe the alternatives, and the environmental staff of TES and WCC will perform the environmental analysis on the basis of available data, which will be compiled for this purpose. Since the impact issues associated with the two-dam scheme for the Upper Susitna have already been identified, this scheme will be used as the yardstick against which other alternatives will be measured.

(c) Discussion

The evaluation of alternatives will be completed as part of Task 1 - Power Studies.

Subtask 7.04 - Water Resources Analysis

(a) Objective

The primary objective of the water resources analysis is to generate data that will be used to determine if the anadromous and resident fisheries in the Susitna River or Cook Inlet will be enhanced or adversely impacted by the proposed project. To achieve this objective the following study areas must be addressed:

(1) Changes in river discharge characteristics due to flow regulation.

(2) Changes in water quality due to impoundment including sediment load, temperature, dissolved gas production as well as chemical and biological constituents.

(3) Changes in wintering conditions along the river due to increased low flow during the winter and changes in ice conditions.

A secondary objective of the water resources analysis will be to assist in estimating the benefits to land use, recreation and flood prevention balanced against the inundation of approximately 50,000 acres above the two dams.

(b) Approach

Accurate baseline water quantity and quality data are essential for predicting the effect of the Susitna Project on the fisheries of the Susitna River and for assuring that construction, filling and operation of the hydroelectric project can be accomplished while achieving possible beneficial environmental effects.

The water quantity and quality information needed will be taken from the engineering studies, particularly Task 3 - Hydrology, from the fisheries study, and from the water quality studies and geological studies to be done by R&M as part of Task 3 and Task 5 - Geotechnical Exploration.

(c) Discussion

Water quality conditions will be affected above and below the dam sites. Stratification conditions within the reservoirs could cause temperature and dissolved gas problems within the reservoir and downstream. The supersaturation of nitrogen and other atmospheric gases could cause gas bubble disease in the downstream fishery. Previously unknown outcrops of soluble metal compounds could be inundated by the reservoirs causing problems to the resident or developing fish populations. Flow characteristics that are essential for upstream migration of salmon to the spawning grounds and for proper conditions for overwintering of both salmon and resident fisheries will be studied. The section on fisheries' analysis covers these topics in more detail.

Essentially all the technical data required will be available at the completion of Task 3 - Hydrology. However, to ensure that the correct data is collected in a format useful to this subtask, early coordination of the requirements of this subtask, with the lead personnel responsible for the field and office studies completed under Task 3, will be made. Information relative to parameters to be tested, frequency and location will be provided as input to the hydrologic and water quality field studies to be conducted by R&M. Data relative to sediment loads, dropout rates and resuspension downstream of Devil Canyon Dam will also be requested from the hydrological and geological studies group. Stream bed degradation will also be studied.

Finally, these data will be combined with input from the fisheries subtask (Subtask 7.10) to assess the impact of the Susitna Project on the fisheries. The data will also be used in Subtasks 7.07, 7.08 relative to land use and recreational development analysis.

It is anticipated that all activities on this specific subtask will be completed before the FERC license application is submitted. However, final use of the data in other subtasks will not occur until after the license application has been submitted.

At the present time, no distinct water quality program is proposed for the time period after license application submission other than that to be conducted as part of the engineering studies and the in-situ measurements taken in conjunction with fish sampling. If early studies reveal a need for further water quality analysis, a program will be developed and proposed at that time.

(d) Level of Effort

Task Force (TES)	$ 7,000
Task Force (Acres)	3,500
Total Subtask 7.04	$10,500

(e) Schedule

Weeks 1 through 130

Subtask 7.05 - Socioeconomic Analysis

(a) Objective

The objective of this subtask is to identify and describe the existing socioeconomic conditions and to determine which are most likely to be impacted by the Susitna Hydroelectric Project, as required under the Federal Energy Regulatory Commission regulations. Subsequent to the submission of the FERC license application, the detailed analysis and assessments of the socioeconomic impacts related to the Susitna development will be completed. Also the supplemental material to amend the current Corps of Engineers' EIS for the Susitna Project will be prepared.

(b) Approach

The completion of the socioeconomic analysis is not a prerequisite to submission of the FERC license application. Thus, the work packages to be completed have been divided into those that must be completed prior to application submission (1 to 4 below) and these work packages that may be completed during a later time period (discussed in Section A.6). The work packages to be completed are:

(1) literature search

(2) socioeconomic profile development

(3) forecast of future socioeconomic conditions in the absence of the Susitna Project

(4) preliminary socioeconomic impact studies

(5) forecast of future socioeconomic conditions with the Susitna Project

(6) identification and evaluation of significant socioeconomic project impacts

(7) assessment of economic aspects of important commercial, recreational and subsistence fish and wildlife resources both with and without project conditions

(8) determination and evaluation of project impacts on important commercial, recreational and subsistence fish and wildlife resources

(9) assessment of social significance of the economic impacts of the project on important commercial, recreational and subsistence fish and wildlife resources

ACRES

Impact studies of projects similar to the proposed project will be identified and evaluated in the first step. Socioeconomic profiles covering the immediate vicinity of the project, broader regions, and the state are developed in the second step. Next, the socioeconomic conditions most likely to be impacted by the Susitna Project are identified and described in depth. For the identified socioeconomic conditions, forecasts of future conditions are made. These forecasts will serve as a baseline for the preliminary socioeconomic impact studies as well as the detailed socioeconomic impact assessments of project impacts to be completed in step 6.

Potential impacts of the project are next determined by comparing the forecast "with the project" to the baseline forecast. This analysis will yield quantitative estimates for impacts as well as qualitative descriptions of impacts. Finally, an assessment of impacts is performed to determine social and economic significance.

(c) Discussion

Impact studies of hydroelectric projects similar to the proposed Susitna project will be reviewed. These reviews will provide a range of impacts which may be expected to result from the proposed project. Next, detailed socioeconomic profiles will be developed in the following areas:

- Demographic data, current and projected
- Housing and public facilities' data
- Employment opportunity and income levels
- Business climate
- Government and infrastructure
- Tax consideration
- Transportation consideration
- Life style and quality of life
- Growth and development attitudes

These profiles will also include the range of impacts which may be expected in the Alaskan environment. The range of impacts for large hydroelectric projects combined with those in the Alaskan environment will constitute a comprehensive list of potential impacts which may result from the proposed Susitna project.

In the final step to be completed before license application submission, relevant socioeconomic conditions are forecast. This forecast is made assuming the Susitna Project will not be undertaken. It includes only those areas which would be impacted by the Susitna Project.

(d) Level of Effort

Task Force (Orth & Associates)........	$169,000
Task Force (TES)	13,200
Liaison and Review (Acres)	2,800
Total Subtask 7.05	$185,000

ACRES

(e) <u>Schedule</u>

Weeks 1 through 87

Subtask 7.06 - Cultural Resource Investigation

(a) Objective

To identify the archaeological and historical resources of the project study area and to propose mitigation measures to lessen the impact of ground-disturbing preconstruction and construction activities.

(b) Approach

Cultural resource experts at the University of Alaska Museum (the Museum) will execute an intensive five-step research effort specifically tailored to satisfy both state and Federal legislation pertinent to cultural resources. The five steps are:

(1) preparation for field studies;
(2) reconnaissance level archaeological survey of project areas;
(3) intensive testing of archaeological and historic sites discovered during step (2) above;
(4) final report preparation; and
(5) curation of all collections in accordance with state and federal requirements pertinent to the preservation of antiquities.

(c) Discussion

Little is known of the prehistory and history of the Susitna Project study area as few archaeological investigations have been done in this area. It is known, however, that six prehistoric and thirteen historic sites have been identified in the study area. In surrounding areas where archaeological investigations have been more intense, 630 prehistoric and historic sites have been documented. These facts suggest that more intensive work in the project study area will uncover as yet unidentified sites.

In step 1, the Museum will apply for, and secure, a Federal Antiquities Permit. They will also seek any state documents that may be necessary for the archaeological portion of the project. The Museum will also conduct an exhaustive literature review of available documents that pertain to topics relevant to their investigation in this phase. The results of the literature search will be used to synthesize the regional and local cultural chronology of the study area.

Also during step 1, aerial photos will be examined to determine areas of probable cultural resources. A preliminary aerial reconnaissance of the study area will also be conducted.

Using the existing information base and relying upon findings of Step 1 efforts, a research design will be developed. Sampling designs will also be established to specifically address the data collection needs of this project.

Step 2 will consist of the archaeological reconnaissance of the area to identify, locate, and inventory archaeological and historic sites. Any discovered sites will later be subject to more intensive investigations. Also, during this step, archaeological sites in areas to be disturbed by other preconstruction study activities will be investigated.

Step 3 consists of intensive testing of sites located during the reconnaissance survey. Each site will be divided into grids, and a sampling scheme applied for testing. Also, site maps and soil profiles will be prepared.

Photographs will be taken to document artifacts and features in situ as well as to document the site and its location. Site limits will be delineated and data will be recovered for analysis and evaluation. National Registry will be proposed for all sites meeting National Register of Historic Places criteria.

Step 4 will be an integral part of each step of the project. It entails the compilation of the individual reports for the other steps of the project as well as synthesizes all data recovered and makes appropriate recommendations for mitigation, if necessary. Step 4 is specifically aimed at the final analysis of the project in terms of sites located and documented during the other study effort steps.

Step 5 involves the curation of materials deposited in the Museum. All artifactual material and associated contextual data will be curated in an ongoing program throughout the duration of the project in a manner consistent with state and Federal requirements for the preservation of antiquities.

(d) Level of Effort

Task Force (University of Alaska Museum)	$541,200
Task Force (TES)	24,200
Liaison and Review (Acres)	6,000
Total Subtask 7.06	$571,400

(e) Schedule

Weeks 1 through 118

ACRES

Subtask 7.07 - Land Use Analysis

(a) Objective

The objective of this analysis is to evaluate the present and future land use trends and to identify the major changes in land use trends that would result with the development of the project. Having identified land ownership and changes in land use trends due to the Susitna project, the land use impacts that would occur in the study area as a direct result of the development of a project will be determined and the significance of these impacts evaluated.

(b) Approach

The approach is basically an analysis of land use trends to determine the major effects the project will have on the future and use of the area. The historical land use trends will be analyzed and the present land use of the area will be examined. The future land use of the area without the project will be predicted on the basis of interviews with land owners, land managers and resource agencies, and a consideration of the resource potentials and limitations. Unique and significant scenic and natural features of the area will be identified for consideration during the impact analysis. A preliminary evaluation of the potential land use impacts will be conducted, and the predicted major effects of the project will be identified for inclusion with the FERC license application.

Subsequent to submission of the license application, a more comprehensive land use analysis will be completed based on a detailed description of lands that would be developed and more detailed information on the proposed operation of the project.

This would include a refinement of the information that was generated during the previous phase, and a more detailed analysis of the lands and land potentials that will be directly impacted by the project. The probable impacts that were identified in the pre-license application phase will be evaluated thoroughly, and the land use changes that can be expected to occur as a direct result of the project will be described. The significance of the changes will also be evaluated and discussed.

(c) Discussion

This phase of the land use analysis will identify the major land use impacts that are predicted to occur as a result of the Susitna project. The first step in the land use analysis will be the identification of the project area boundaries. These boundaries will include adjacent lands that will be affected or influenced by the project, as well as access roads and transmission corridors. The downstream effects will also be considered in the overall land use analysis. The boundaries will be flexible and adjusted as updated information is obtained.

An understanding of the historical land use trends is necessary to isolate the factors and management decisions that have resulted in the present land use patterns. This understanding will be developed through a review of the University Archives materials, additional published sources, and interviews with agency and native leaders. Of particular importance will be the identification of any cyclic changes that have taken place.

A complete description of the present land use will be developed. A base map and photo file will be developed along with a narrative description. The present land use will be described in terms of the extent of present uses such as forest land, recreation, wildlife, developed uses, etc. As much as possible, this description will include a discussion of the planning efforts that have resulted n the present utilization of the land.

Having identified the lands that may be affected by the Susitna Project, the next step will be to determine land ownership as Federal (including agency jurisdiction), state, private, and Native Corporation. Land ownership status may be in transition due to the Alaska-Native Claims Settlement Act and State Selection under the Statehood Act. Land management plans and regulations affecting alternatives will be evaluated. The various Federal and state agencies, and some Native Corporations will have land classification and management systems governing activites that are allowed on those lands and waters being managed.

To predict the future land use without the project, area lands will be evaluated in terms of resource potentials and limitations for alternative uses. This evaluation will be accomplished in relation to other expected changes that are predicted to occur within the area such as changes in land ownership, access, etc. The major land owners and land managers will be interviewed to discuss their future plans for the area. The anticipated changes that are predicted by the land owners and managers, as well as other agencies, will provide insight into the most probable future of the land.

The significant land uses that have been identified during the previous steps will be examined during a field reconnaissance of the area. Unique or significant scenic and natural areas that have been tentatively identified on aerial photographs will also be examined during this initial field reconnaissance. These unique and significant features will be described, and the impacts on the features will be evaluated in more detail.

Finally, the potential land use impacts of the proposed project will be evaluated with the objective of identifying the major impacts that can be predicted to occur as a result of this project. The impacts will be identified on the basis of all the information that has been developed prior to license application submittal. The impacts that are identified during this phase will be evaluated in greater detail during the next phase of this analysis.

It should be noted that the Land Use Analysis will draw nearly on the physical outputs of Task 2: Surveys and site facilities for assistance in mapping of current land use and provisions of aerial photos of the project area.

(d) Level of Effort

Task Force (TES)	$19,200
Task Force (University of Alaska Museum)	48,800
Liaison and Review (Acres)	1,000
Total Subtask 7.07....................	$69,000

(e) Schedule

Weeks 1 through 126

Subtask 7.08 - Analysis of Recreation Development

(a) Objective

The objectives of this subtask are:

(1) to develop a procedures' manual that will provide the framework for the development of the master plan for the recreational use of the project lands and waters;

(2) to conduct a review of the literature pertinent to this planning effort

(3) to develop a base map of the study area identifying the primary attractors within the area and a preliminary zoning of areas suitable for recreational development.

(b) Approach

Dr. Alan Jubenville, Principal Investigator for this subtask effort, will prepare a procedures' manual that will provide documentation of the study design, sampling methodologies and analysis procedures to be followed throughout this planning process. A review of the existing literature will be conducted to accumulate background information on water resource planning for recreation, supply-demand modeling, participation patterns, changes in socioeconomic casual factors and user perceptions of specific recreational experiences. A preliminary assessment of the resource potentials for recreation will also be conducted, utilizing aerial photography and field reconnaissance. On the basis of this preliminary assessment, a base map of the area will be developed.

(c) Discussion

The procedures manual will be developed to establish a detailed framework for the entire planning process. It will be developed in this initial phase to insure that study design, data collection and data analysis are consistent with the needs of this planning effort. It will also insure consistency throughout the process, including the application of field evaluation techniques.

The review of the existing literature will provide information necessary for the development of the recreation plan. It will include a complete review of pertinent perodicals and texts, and agency publications related to Alaska, including the Statewide Comprehensive Outdoor Recreation Plan. It will also review Susitna Valley references, both popular and technical.

The potential of a given parcel of land for recreational use is directly related to the benefits that people can derive from using it. The potentials are determined by the setting and natural attributes of the site, and also by the capabilities of the site to withstand use. Both of these considerations will be used in this planning process to evaluate the potentials of the resource for recreational use.

A preliminary assessment of the resource potentials will be completed in this phase. An initial evaluation of the project area will be completed in the lab, using vertical aerial photography to isolate potential sites. The project lands will be evaluated on the basis of general resource capabilities, levels of access and anticipated management problems (such as natural hazards). This initial evaluation will determine the zones that have greatest potential for development. Selected suitable areas, potential visitor attractions and related management concerns will be located on a base map and evaluated during a field reconnaissance. The summer field season will be spent assessing the potentials and the inherent limitations of the areas. Standardized criteria will be utilized to eliminate personal bias in the field site evaluation process.

(d) Level of Effort

Task Force (TES)	$ 9,700
Task Force (University of Alaska)	14,400
Total Subtask 7.08	$24,100

(e) Schedule

Weeks 52 through 126

Subtask 7.09 - Susitna Transmission Line Assessment

(a) Objective

The objective of this task is to provide input into the selection of an environmentally sound one-half mile wide transmission line corridor from the Susitna Project area to load center substations in or near both Anchorage and Fairbanks.

(b) Approach

The corridor will be selected by means of the following process:

(1) conduct literature search for pertinent data sources;

(2) concurrently, obtain aerial photography and land-based photography for the study area routing analysis;

(3) review alternative routes proposed by previous studies and select project-specific alternative corridors;

(4) conduct site-sensitive avoidance routing analysis on alternative routes;

(5) provide input into the selection of a primary, one-half mile wide corridor;

(6) define criteria for establishing and conducting final design and location analyses.

(c) Discussion

A wealth of data dealing with the selection and evaluation of transmission line corridors exists with respect to the Susitna Project (note list of previous studies at end of discussion). Several studies have been obtained and reviewed. They will serve as a basis for initiating project investigations. All data sources pertinent to a routing impact analysis will be obtained and catalogued for further reference.

Aerial photography exists for much, if not all, of the proposed routing analysis study area. In addition, other photography available for the study area, including land-based photography, will be sought. Many sensitive or unique areas within the Central Railbelt area have been photographed during previous studies, including many areas within the transmission corridor study area. All such available photographs will be catalogued and stored for further reference.

Transmission line corridors proposed by other studies will be reviewed and recommendations as to their environmental acceptability will be provided. Criteria will be established for the purpose of avoiding, where possible, areas such as wetlands, steep mountain slopes, scenic vistas, population centers, and other constraints.

The criteria will be applied to all alternative route segments. Following an analysis of the data, a primary corridor of approximately ten miles will be selected.

Additional criteria will be established to provide rationale for further refinement of the primary corridor. Items such as access, clearing requirements, soils limitations (where applicable) and restoration requirements, to name a few, will be factored into the analysis process. The end result of this effort will be a proposed primary corridor of one-half mile width between the project and both Anchorage and Fairbanks.

TES will assist Acres in the selection of both the ten mile and one-half mile wide primary transmission line corridors. Based upon the alternative routes proposed by Acres, TES will conduct the necessary environmental analysis and identify sensitive areas. TES will also provide environmental input into the development of criteria to be utilized for further corridor refinement studies.

List of Previous Studies

1) International Engineering Company, Inc., Anchorage-Fairbanks Transmission Intertie - Economic Feasibility Study Report April 1979.

2) Robert W. Retherford Associates, North Slope Natural Gas Transport Systems and Their Potential Impact on Electric Power Supply and Uses in Alaska, March 1977.

3) U.S. Army Corps of Engineers, Southcentral Railbelt Area, Alaska, Upper Susitna River Basin Interim Feasibility Report, (Appendix I, Part II (G) Marketability Analysis, (H) Transmission System, (I) Environmental Assessment for Transmission Systems, December 1975.

4) Kozak, Edwin, under the direction of J. R. Eaton, Performance Characteristics of a 350-Mile Electric Power Transmission Line (Fairbanks to Anchorage), A project in EE 494, Department of Electrical Engineering, University of Alaska, June 1973.

5) Ch2M-Hill, Electrical Generation and Transmission Intertie System for Interior and Southcentral Alaska, 1972.

6) Federal Power Commission, Alaska Power Survey, 1969.

7) Alaska Power Administration, Alaska Railbelt Transmission System, working paper, December 1967.

8) The Ralph M. Parsons Company, Central Alaska Power Study, undated.

9) The Ralph M. Parsons Company, Alaska Power Feasibility Study, 1962.

ACRES

(d) Level of Effort

Work Force (TES) $18,000
Work Force (Acres) .... $ 6,000

Total Subtask 7.09 .... $24,000

(e) Schedule

Weeks 1 through 130

Subtask 7.10 - Fish Ecology Baseline Studies and Analysis

(a) Objective

(1) to evaluate the resident fishery in the Susitna River and predict the effects of the Susitna Hydroelectric Project during construction, filling and operation;

(2) to evaluate the anadromous fishery (salmon) in the lower Susitna River and Cook Inlet and predict the effects of the Susitna Hydroelectric Project on migration, spawning and survival of the Susitna River salmon;

(3) to identify areas needing possible future study; and

(4) to provide essential information for license application.

(b) Approach

The studies proposed at this time have been based upon the establishment of an Operations Office in Anchorage for the coordination and administration of the studies, and subcontracting portions of the studies to research groups at the University of Alaska and/or state or Federal agencies including ADF&G. These research units are competent in the specialized disciplines required, are familiar with the field conditions in Alaska and, in general, provide an efficient base for the studies.

(d) Discussion

The construction of power dams on the Susitna River can affect positively or negatively portions of the salmon runs and game fish resources of the Susitna River Basin. The studies necessary for an understanding of the effects on the game fish resources below the dam sites are essentially the same as those required to protect or enhance the salmon resources in the same area. It is reported (for example, Corps' EIS for the Susitna Projects) that there are no salmon stocks above Devil Canyon. There are, however, game fish above that section that will be affected by the creation of lakes as opposed to the free-flowing river.

The extent to which the main river is used, both for spawning and rearing of commercial species, has yet to be demonstrated. It is known that both adults and juveniles use the river channel for transportation to their spawning and rearing areas. There may be, as there are in many streams, a winter-over capacity utilized by many fish that normally reside in clear tributaries but migrate into areas that have continuous winter flows and, therefore, this river may play an important part in their life cycle. This is a necessary part of the study.

This project, like all hydroelectric projects in which major storages are involved, has three periods that must be considered after the baseline studies have been conducted. These periods are the construction period, the filling period and plant operation. The baseline studies are required to develop criteria for protecting the fish and, perhaps, in the final period, enhancing the fishery.

During the first phase of this project the following studies are proposed.

- Evaluate the contribution of the Susitna River salmon population to the Cook Inlet fisheries. An attempt will be made to determine quantitatively the portion of the total catch originating in the Susitna River drainage. Identification and separation of the various stocks will be made by using differences in scale patterns and by electrophoresic analyses of tissue samples.

- The distribution and movement of adult and juvenile salmon in the lower Susitna River will be examined. The location and importance of known salmon spawning areas in the lower Susitna River as well as the time and migratory patterns of the various species and races of salmon ascending the river will be examined.

- The production of the proposed reservoirs will be evaluated by examining lakes in the general area of the proposed reservoirs. This study will be done by using available data with field data being collected as needed.

- A search will be conducted to determine the presence (or absence) of endangered species. The Endangered Species Conservation Act of 1969 and subsequent regulations give the Secretary of the Interior broad powers to protect a species of fish whose existence is threatened with destruction, drastic modification, or severe curtailment. The extent of these powers are already well demonstrated by the famous case of the snail darter, and accordingly every effort must be made to determine if any endangered species live within the areas to be inundated.

- Water quantity and quality data collected in Subtask 7.04 will be needed to establish baseline information. These data will provide information for developing criteria for the construction phase, the filling phase and the operational phase. Gauging stations will be placed at predetermined sites as part of Task 3 work effort. Flow, sediment and other parameters will be measured at each station.

- The basin above the dam sites will be examined to determine the fish stocks that are likely to populate the reservoirs.

- Ice cover will be examined and the problem of frazile ice will have to be evaluated (input from Task 3). A literature review will be done to examine the problems that may have arisen at other projects in sub-arctic zones. The stability of the present stream bed below the dam sites should be measured (input from Task 3).

All of the studies are necessary to judge the effects that the Susitna Hydroelectric Project might have on the aquatic habitat and subsequently the fisheries. The anadromous fisheries should be examined through a complete cycle, although this extends beyond the scheduled time of license application. Thus, the post-license application submission studies will be required to adequately address the impact of the proposed project upon this important resource.

(e) Level of Effort

Task Force (TES)	$ 74,000[1]
Task Force (Consultants and University of Alaska).	695,600[1]
Task Force (ADF&G)	494,600[1]
Liaison and Review (Acres)	12,600
Total Subtask 7.10	$1,276,800

(f) Schedule

Weeks 1 through 130

(1) Subject to refinement following negotiations between APA and ADF&G.

Subtask 7.11 - Wildlife Ecology Baseline Studies and Analysis

(a) Objective

The primary objective of this subtask is to accurately determine the impact the proposed Susitna Project will have on the wildlife resources of the Upper Susitna River Basin. In order to accomplish this objective, it will first be necessary to: 1) determine the species present, their distribution and relative abundance; 2) gather sufficient data to develop an understanding of the relationship between key wildlife species and the distribution, quality and seasonal utilization of habitat components; and 3) determine the predator-prey relationships that exist in the terrestrial system. Since there are complicated interrelationships among all faunal members of the terrestrial community, be they key species or not, it is necessary to consider all components of the system in order to gain a total understanding of community dynamics.

(b) Approach

In order to achieve the objectives of this study, an appropriate approach has been developed for each section. Following is a summary of the approach that will be taken in regards to: 1) big game, 2) furbearers, and 3) birds and small mammals.

(1) Big Game

It is anticipated that the Alaska Power Authority will contract directly with the Alaska Department of Fish and Game (ADF&G) to collect and analyze the baseline data needed to evaluate the project impact on big game. Thus, all portions of this Plan of Study that concern big game are based on the March 1978 program developed by ADF&G. ADF&G will be requested to conduct that portion of their program dealing with the following species: moose, caribou, wolves, bears, wolverines and Dall sheep. Although ADF&G did outline an effort to study mitigation measures for moose, we recommend that this portion of the effort be reassessed and developed in more detail during the first two years of the study; therefore, this portion is not included in the present program. In order to assure that the big game portion of this study is coordinated with the entire environmental analysis effort, the Environmental Study Managers designated by Acres and TES will maintain close liaison and coordination with ADF&G's staff. Both APA and Acres' Project Manager, J. Lawrence, will receive minutes of all meetings held.

Acknowledging that ADF&G is the group best qualified to collect the baseline data on big game, there exists the potential of a conflict if ADF&G were to conduct the impact analysis as well as serve in a regulatory review capacity. In order to avoid any delays that could occur if this conflict is challenged by other agencies or interveners, we propose a team of TES staff and expert consultants to develop an impact assessment based on data collected by ADF&G. The securing of an independent assessment will avoid serious problems that could develop if ADF&G were to serve in the dual capacity of performing both impact analysis and impact review. Because the impact assessment is extremely important, the selection of an appropriate individual or team should not be a hasty process. Therefore, we propose to utilize the first year of the study to form the team. We shall solicit recommendations from ADF&G, USF&W and other agencies and secure the approval of the APA prior to finalizing any arrangements.

Following is a list of species-specific tasks proposed by ADF&G to be conducted during the data collection portion of this program. Collection of these data is necessary to achieve the objectives of the study. These tasks will be initiated prior to submission of the FERC license application and continued approximately three years after the submission of the application.

Moose

Preparation of a vegetation type map of areas within and adjacent to proposed impoundments, along transmission corridors and along the downstream floodplain.

Identification of key moose browse species and determination of the condition and trends of selected moose habitats.

Determination of the effects of altered water flow on key plant species and mapping of areas where substantial vegetation changes will occur.

Identification of moose subpopulations using habitat that will be subject to direct and indirect impact of the Susitna Hydropower Project.

Determination of the seasonal distribution, movement patterns, size and trends of those subpopulations.

Determination of the timing and degree of dependency of those subpopulations on habitat to be impacted by the Susitna Hydropower Project.

Caribou

Identification of subpopulations of caribou in the Nelchina Basin.

Determination of the seasonal ranges and migration routes of these subpopulations with emphasis on traditional migration routes across proposed impoundment areas and potential alternative routes.

Determination of the availability of suitable alternative seasonal ranges to caribou subpopulations that might be isolated from traditional ranges by the proposed impoundments.

Wolves

Determination of the number of wolf packs that inhabit areas to be directly affected by the Susitna Hydropower Project, and the number of wolves in each pack.

Determination of the proportions of each pack's territory that lie within areas of impact.

Determination of the location of dens, rendezvous sites, hunting areas and the other essential activity areas of each pack in relation to proposed impoundments and construction activities.

Determination of the dependence of each pack on prey populations that may be adversely affected by the project.

Bears

Estimation of the numbers of black and brown/grizzly bears using the area to be impacted by the Susitna Hydropower Project.

Determination of the dependency of these bears on areas to be impacted, with emphasis on identification of denning areas and seasonal feeding areas.

Wolverines

Determination of the population status of wolverines using areas to be impacted by the Susitna Hydropower Project.

Determination of movement patterns and identification of habitats of seasonal importance of wolverines.

Dall sheep

Determination of the numbers of Dall sheep inhabiting mountains adjacent to proposed dam sites.

Delineation of the seasonal ranges of the sheep population

(2) Furbearers

The furbearer study effort during the pre-application phase will be a two-year survey and will include an extensive investigation of populations within the project region. This will include a literature search, as well as the identification of key species, general abundance levels, and the location of critical habitats. To accomplish this, data will be gathered from aerial surveys and ground surveys, and as much data as possible will be obtained from trappers. Based on the results of these surveys and the vegetation cover map, as well as data collected from other portions of the study (e.g., small mammals), a general map of critical habitats and areas of notable abundance will be produced.

(3) Birds and Small Animals

We propose to use an extensive approach for the pre-application phase of these studies. The extensive bird study will alert us to the presence of possibly unexpected species or unexpected concentrations of species, and it will enable us to compare the avifauna (species, relative abundance, habitat use and seasonal chronologies) with better known Alaska taigas, giving us the necessary base for impact predictions. The extensive study will also provide data on species not found in the habitats of the intensive study sites where sampling will be conducted.

In regards to small mammals, trapping efforts will be conducted to determine the species of small and medium-sized non-game mammals occurring in the region. For each of the major habitats of the region, species composition, relative abundance and habitat use will be determined.

(c) Discussion

In dealing with such a large area as is represented by the Upper Susitna River Basin, and attempting to develop an adequate understanding of potential impacts and possible mitigation measures, it is necessary to study the entire faunal community and delineate the complex interrelationships that exist among the components of the terrestrial system. We realize that certain portions, or species, within the system are considered important by certain groups or agencies. This plan of study has been designed to concentrate on such important species; however, regardless of the importance of these species, they are all part of the total community system and a satisfactory understanding of any member of the system cannot be developed without investigating the entire system. Many of the study plans that preceded the development of this plan failed to express an understanding of the complexity of the situation and subsequently ignored many species that are integral to the total dynamics of the system, or may be considered important by other portions of our society. This plan of study is designed to assure that a complete, and thus more accurate, assessment of the wildlife-related impacts will be executed.

These initial studies include all portions of the work effort that, at a minimum, will have to be conducted if an adequate license application is to be prepared. Most of the data will be available for inclusion into the application; however, in regards to big game, a 4 to 5 year effort will be necessary. It is virtually impossible to gather adequate data on these species within the time allotted for the preparation of the application. Therefore, the license application will include only preliminary data and tentative discussions concerning big game impact. It is vital that all parties concerned realize that in the case of many species a minimum of 4 or 5 years is needed to gain a thorough understanding of habitat and predator-prey relationships. In addition, many species, particularly small to medium-sized mammals, demonstrate cyclic changes in density; and thus a 1 or 2 year study is highly restrictive in perspective. Likewise, larger species such as moose and caribou demonstrate different movement patterns and habitat needs under various weather conditions. So here again, sufficient time must be expended in gathering an adequate data base. Studies proposed after the licensing application is submitted are designed to satisfy the time requirements of some aspects of the Susitna study and assume that adequate consideration of the basic research needs are addressed.

(d) Level of Effort [1]

Task Force (TES)	$ 91,800 [1]
Task Force (University of Alaska)	506,900 [1]
Task Force (ADF&G)	1,361,300 [1]
Liaison and Review (Acres)	14,000
Total Subtask 7.11	$1,974,000

(e) Schedule

Weeks 1 through 104

[1] Subject to refinement following negotiations between APA and ADF&G.

Subtask 7.12 - Plant Ecology Baseline Studies and Analysis

(a) Objective

The objectives of the plant ecology program are to map and characterize the vegetation and habitat types occurring in the areas to be affected by the proposed Susitna Hydroelectric Dam Project and to predict impacts that will result from the proposed facilities.

(b) Approach

Vegetation types will be mapped on topographic maps of the area as well as on LANDSAT, high-altitude (U2), and low-level aerial photography. Respective land areas covered by each vegetation/habitat type will be determined by manual planimetry or computer integration from LANDSAT imagery after the types have been circumscribed. Ground verification and qualitative assessments will be performed. Sensitive habitats, especially wetlands and those containing proposed endangered or threatened species of plants, will be emphasized, and any natural landmarks (U.S. National Park Service Programs) in the area will also be noted.

Preliminary impact assessments of the ecological effects of the dam project, access road, and the siting of transmission lines will be made as the proposed routes are developed, and the field studies are performed.

(c) Discussion

The characterization of vegetation types within an area provides a great deal of information for use in environmental studies. Such information is not only used for the prediction of impacts on plant communities, but it is also used in predicting wildlife habitat removal and changes in land use patterns.

This phase of the vegetation analysis will include a literature review, the preparation of a vegetation cover map, a qualitative assessment of the major vegetation types, a timber inventory, a review of proposed endangered species, and a preliminary impact assessment. Each vegetation type will be mapped on aerial photographs, ground truthed and qualitatively assessed for general species composition. The mapping will primarily be performed in the June-September 1980 period with refinement and additional mapping for the access road and transmission corridors being performed in 1981.

Although there are no plant species presently listed for Alaska as endangered or threatened by Federal or state authorities, six species have been proposed by the Fish and Wildlife Service for protection as endangered. For these species distribution and habitat information will be assembled from literature and herbaria sources. Known stations and potential habitats for these species in the study area will be searched to determine the present status.

A review of the available literature will be performed throughout the study to elucidate data voids and support report discussions. A forest inventory will be performed using standard U.S. Forest Service methods.

Impacts on vegetation will be predicted utilizing information gathered prior to license application. The prediction of vegetation impacts will rely primarily on the vegetation cover type maps. Acreage of the various cover types to be destroyed or altered will be estimated.

(d) Level of Effort

Task Force (TES)	$ 54,000
Task Force (University of Alaska)	189,800
Total Subtask 7.12	$243,800

(e) Schedule

Weeks 1 through 117

Subtask 7.13 - Geological Analysis

This subtask will be completed as part of the studies conducted under Task 5 - Geotechnical Exploration.

Subtask 7.14 - Access Road Environmental Analysis

(a) Objective

The objectives of this subtask are to provide input into the selection of an access road route that will be environmentally sound and to provide an impact assessment of the preferred route.

(b) Approach

This subtask will initially involve the comparison of alternative routes. Major environmental constraints will be mapped along the various proposed alternative routes. One preferred route will then be selected that will be feasible from environmental, economic and engineering viewpoints. Direct and indirect impacts of the proposed action will be discussed in the environmental report.

(c) Discussion

The first part of this subtask will be the screening of alternative routes. The screening process will be a coordination effort between R&M Consultants, Inc., Acres and TES. R&M and Acres will initially propose various viable alternative routes or areas where viable alternatives could be proposed. TES will then provide a map or a discussion of the various major environmental constraints, (cultural resources, critical wildlife habitats, wetlands habitat for endangered or threatened species, etc.) in these areas. A proposed route will then be selected taking environmental, engineering and economic concerns into consideration.

Once a proposed route is selected, more detailed environmental information will be collected for that specific route. Examples of environmental information include a vegetation cover map, wildlife habitats, biological information for any water bodies crossed and other pertinent environmental information.

Impacts of the proposed access road will be presented. The impacts of associated activities, such as the acquisition of fill material, will be addressed. Socioeconomic, land use, and recreation impacts related to increased access to the area will also be discussed.

The comparison of alternative access roads will be performed primarily in the first year. More detailed information on the proposed route will be collected during the second summer.

(d) Level of Effort

Task Force (TES)......................	$26,000
Liaison and Review (Acres)	2,000
Total Subtask 7.14	$28,000

(e) Schedule

Weeks 1 through 112

Subtask 7.15 - Preparation of FERC License Application Exhibits

(a) Objective

The objective of this subtask is to compile and organize the reports of all the various environmental disciplines into one environmental report required for the license application submission to the Federal Energy Regulatory Commission.

(b) Approach

The collation and organization of the various environmental reports into a license application environmental report will require keeping abreast of the changes in regulations, report format and implementation procedures throughout the project period. An environmental report commensurate with the regulations in effect during the time of submission will then be prepared.

(c) Discussion

An environmental impact statement for the proposed Susitna River Project is required under various Commission Orders of the FERC, and in accordance with the National Environmental Policy Act (NEPA). Presently the FERC regulations pertinent to the environmental studies are Exhibits R, S, V and W. For major hydroelectric projects, these Exhibits are currently being reorganized into Exhibit E-Environmental. Officials of FERC are not certain as to when the reorganization will be completed, but it will be effective before application submission for the Susitna Project.

As the project prgresses any revised environmental legislation pertinent to the proposed project will be obtained. These regulations will be reviewed and action taken to insure compliance as part of the Coordination Subtask (7.01).

Regulations in effect at the time of the permit applicatiion will be used for preparation of the exhibits for the environmental report. Although the format of the environmental report will depend upon the revised regulations, it is anticipated that the FERC environmental report outline will follow the recently effective (July 30, 1979) Implementation of Procedural Provisions promulgated by the Council on Environmental Quality. Certain parts of the reports for the various disciplines will be summarized or reorganized to meet the requirements. Sections typing different disciplines together will also be prepared.

(d) Level of Effort

Task Force (TES)	$ 44,500
Liaison and review (Acres)	4,500
Total Subtask 7.14	$ 49,000

(e) Schedule

Weeks 105 through 125

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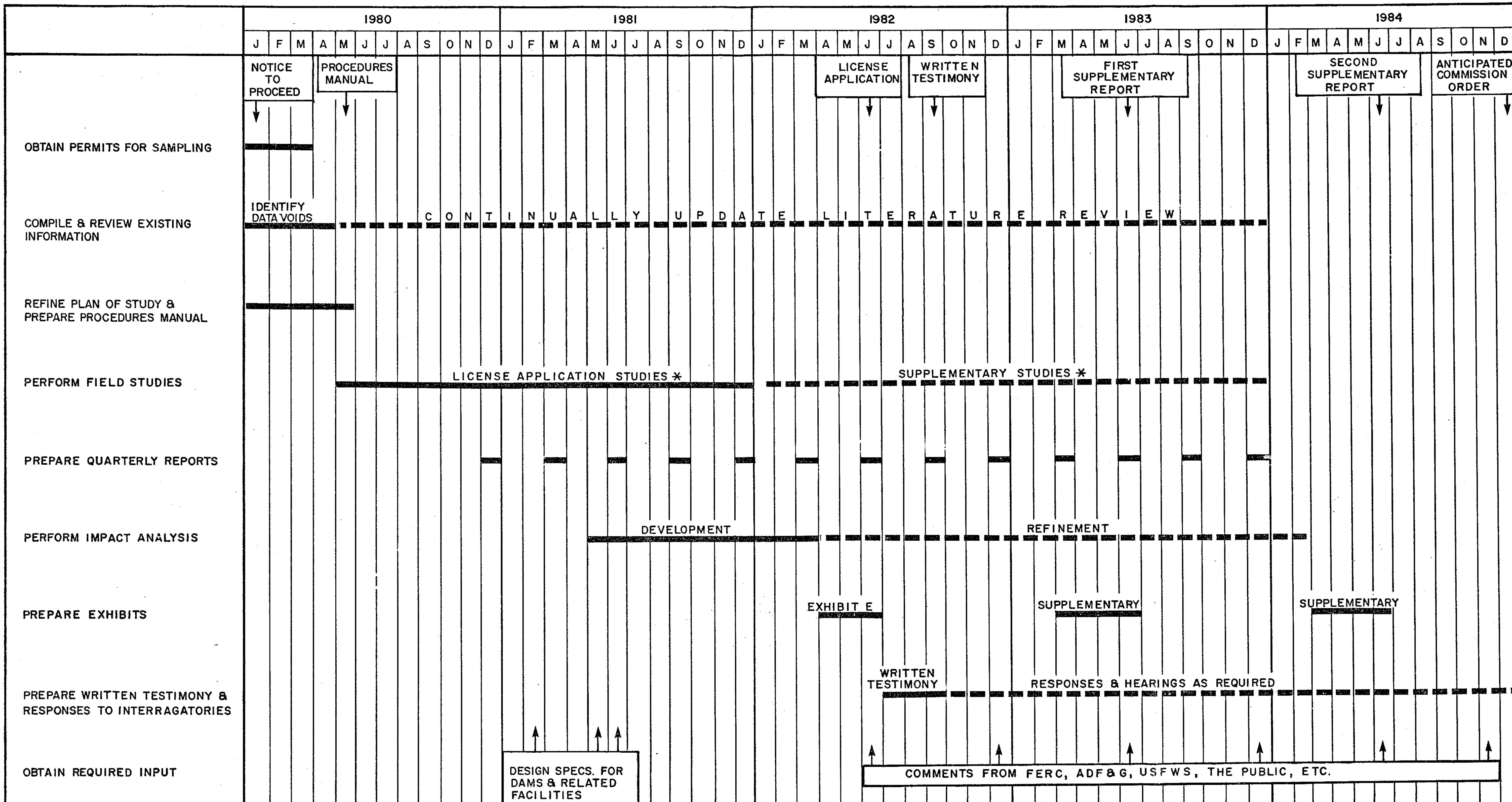

* LICENSE APPLICATION STUDIES

SOCIOECONOMICS
CULTURAL RESOURCES
LAND USE
RECREATION
WATER QUALITY
FISHERIES
WILDLIFE
PLANT ECOLOGY

* SUPPLEMENTARY STUDIES

(ALL DISCIPLINES, AS REQUIRED)

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SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY
PLATE T7.1: TASK 7 SCHEDULE

TASK 8: TRANSMISSION

A.5.9 - TASK 8: TRANSMISSION

(i) Task Objectives

To select the transmission route, produce conceptual designs and cost estimates for the FERC license application for the following project components:

- Transmission line linking the project damsites to Fairbanks and Anchorage, together with potential intermediate stations to feed local communities

- Substations, with particular reference to the two major terminals at Fairbanks and Anchorage, together with a suitable design for intermediate load points

- Dispatch center and communications system

(ii) Task Output

During 1980

Issue a design memorandum outlining the results of the Acres review of the 1979 IECO report and a preliminary screening of the routes identified in that report.

During 1982

Basic design information dealing with the following aspects:

- Transmission line voltage level

  .Tower types
  .Route map
  .Conductor data
  .Insulation levels
  .Construction access
  .Construction schedule
  .Cost estimates

- Substations

  .Single-line diagram for each main type of substation
  .General arrangement drawings
  .Transformer criteria
  .Circuit-breaker criteria
  .Outline of relay protection philosophy
  .Cost estimates

- Dispatch Center and Communications

  .Location and size of center
  .Level of automation proposed for remote stations
  .Extent of real-time functions required
  .Type of communication channel proposed together with appropriate data transmission rates
  .Basic type of software
  .Man-Machine interface

In addition, descriptions of the design studies will be written up for inclusion in the Project Feasibility Report and documention for the FERC license application will be prepared.

(iii) List of Subtasks

8.01 - Transmission Line - Corridor Screening - 1980

8.02 - Electric Systems Studies

8.03 - Transmission Line - Route Selection - 1981

8.04 - Tower, Hardware and Conductor Studies

8.05 - Substations

8.06 - Dispatch Center and Communications

8.07 - Transmission Line Cost Estimate

(iv) Subtask Scope Statements

Our basic approach to the work outlined in this task will initially be to review the 1979 IECO report with respect to their approach and their level of detail. Following this, we will undertake more detailed study and conceptual design up to a level appropriate for FERC license and for basic technical and economic feasibility.

Included in this work will be the utilization of such geologic (Task 5) and climatologic (Task 3) field data as can be obtained during that study period. We also propose an extensive field reconnaissance during 1980 plus mapping a limited selection of key sections of the various corridors (Task 2).

The field reconnaissance, review of the IECO studies, and preliminary screening of the corridors will take place during 1980 (Subtask 8.01). During this period we will also start the electric system studies (Subtask 8.02). During 1981 the general location of the transmission line route(s) within the selected corridor(s) will be established (Subtask 8.03) and conceptual designs produced. Design studies and cost estimates for the Towers, Hardware and Conductors (Subtask 8.04), Substations (Subtask 8.05), and Dispatch and Communications Center (Subtask

8.06) will also be developed. Particular attention will be devoted to producing feasibility-type cost estimates and to reconcile the differences between previous estimates made by IECO and the Alaska Power Administration.

Subtask 8.01 -Transmission Line Corridor Screening - 1980

(a) Objective

To initially review the 1979 IECO report, to eliminate some of the less attractive corridors, to identify such considerations of route selection that may require additional work and to plan the 1981 field data collection.

(b) Approach

This activity will involve an extensive field reconnaissance of selected potential corridors. We also anticipate being given full access to all available IECO data with regard to system studies (load flow, etc.) and also structural studies of towers if such exist. This subtask would also include a more detailed review of the economics of a DC alternative.

Once the above-mentioned review studies have been completed, a preliminary screening study will be undertaken to eliminate the obviously less desirable corridors from further consideration. The corridors selected for further study will be identified as bands on the one inch to one mile mapping and made available as input for the biological and foundations studies. The centerline of these bands will also be marked upon existing photography coverage. This, together with the marked-up one inch to one mile maps, will be used to direct the high aerial photographic program which will provide specific coverage along the potential routes.

The preferred corridors will be made available in time for the start of the 1981 summer survey season so that the required geological exploration and mapping work can be undertaken. For this stage of the work, we propose to define a number of key sections of the various corridors for mapping in the 1981 season. Such sections will be chosen as being typical of the various features of the corridor, muskeg, permafrost, steep grades, etc. For the purposes of the present submission, we propose that each section be between 5 and 10 miles in length and that up to 10 such sections will be mapped.

(c) Discussion

The prescreening activities will be carried out on the basis of the following considerations:

- Review of all background data (USBR, IECO,etc.).

- Assessment of differential costs as determined by geological or climate considerations.

- Relative assessment of environmental considerations, land use, etc.

- Review of such power system related aspects as the number of intermediate load points to be served.

We anticipate that this prescreening process will allow us to eliminate in the region of 75% of the currently identified routes.

(c) Level of Effort

Task Force (Acres)........................ $83,200

(d) Schedule

Weeks 11 through 52

Subtask 8.02 - Electric System Studies

(a) Objective

To ensure that the electrical aspects of the project design are integrated with the existing Railbelt area power systems and to design an electrical power system which is reliable and economic.

(b) Approach

The following steps will be carried out:

- Review all previous studies (including source data and computer outputs if available)

- In the event that no load-flow studies have as yet been done, the following data would be obtained from the APA and other utilities:

  -- generating station plant capacity
  -- transmission lines impedances
  -- substation transformer capacities and loads

- Obtain information from the load forecasting study (Task 1) including details of the following:

  --existing load conditions
  --historical load growth
  --load and energy projections
  --daily and annual load duration curves
  --location of load centers

- Meet with APA, the Alaska Power Administration and the Railbelt utilities to obtain system data and review of proposed future expansion at the utility level.

- Determine economic and security criteria and review with APA.

- Determine main and intermediate substation locations and capacities.

- Establish transmission line requirements, including most economical voltage levels together with conductor sizes and appropriate spacings.

- Perform preliminary load flow studies to verify transmission system configuration and parameters.

- Determine line energizing and compensation requirements.

- Establish general electrical equipment specifications such as:

  --insulation levels
  --equipment ratings and connections
  --transformer tap ranges
  --switchyard single-line diagrams

Acres has developed a comprehensive set of computer programs which will be employed to assist the foregoing studies. These programs include:

- Load-flow - Newton Raphson Method (Acres Program No. EL 012)
- Three-Phase Short Circuit (Acres Program No. EL 020)
- Transient Stability (Acres Program No. EL 030)
- Dynamic Stability (Acres Program No. EL 034)
- Transmission Line Dynamic Overvoltages (Acres Program No. EL 831)
- Conductor Thermal Current Rating (Acres Program No. EL 834)

The studies will identify the basic transmission line requirements and characteristics of electrical substation equipment, generation equipment and relay protection.

(c) Discussion

We anticipate that during 1980, load-flow studies would be made for a variety of preliminary system configurations. During 1981, these load flow studies would be refined to represent the preferred system. During the latter period, short circuit and stability studies would also be carried out.

A study of potential grounding problems associated with permafrost as experienced at Prudhoe Bay and the effect on protective ground relaying would also be undertaken.

(d) Level of Effort

Task Force (Acres)....................... $150,800

(e) Schedule

Weeks 20 through 120

Subtask 8.03 - Transmission Line - Route Selection 1981

(a) Objective

To identify two selected routes, each about half a mile wide, one from the project sites to Anchorage and the other to Fairbanks.

(b) Approach

The alternative corridors carried forward from Task 8.01 will be subjected to a further process of elimination and a final route selected. Input to this task will be obtained from the following:

- Preliminary environmental studies (Task 2) including aesthetic considerations

- Land use studies (Task 7)

- Mapping of key sections (Task 2)

- Climatological studies (Task 3)

- Identification of seismic problems (Task 4)

- Geotechnical exploration (Task 5)

- Geotechnical footing design (Task 6)

The possible advantages to be obtained from a staged construction sequence will be evaluated. If appropriate, separate routes for future stages will be identified. The result of this study will be the selection of a complete route, approximately one-half mile wide.

(c) Discussion

In arriving at the final route selection, the following potential design difficulties peculiar to cold climates will be taken into account.

Damage to footings due to frost heave and muskeg conditions. It is known that such problems have been encountered on other transmission lines, specifically on the 230-kV lines between Twin Falls and Labrador City. In designing the 735-kV Churchill Falls lines, Acres successfully overcome these problems by the choice of guyed towers and the careful selection of routes and anchor details.

The possible effect of permafrost conditions on route selection will also be taken into account.

The possible need to contend with extremely high wind velocities such as those encountered at Snettisham will also be reviewed. Such winds cannot normally be accommodated in the design of the transmission line and/or problem can be overcome by rerouting and stockpiling of a number of spare towers.

(d) Level of Effort

Task Force (Acres).................. $206,000

(e) Schedule

Weeks 60 through 120

Subtask 8.04 - Tower, Hardware and Conductor Studies

(a) Objective

To select the most appropriate tower configuration, hardware and conductor arrangements for the line.

(b) Approach

The existing data contained in previous studies, particularly the 1979 IECO report, will be taken into account in developing the following.

(1) Design Criteria

We will establish basic design requirements using the data from field studies and system studies. These include climatologic (Task 3), geotechnical (Task 6) and electrical parameters (Subtask 8.02).

(2) Towers

We will establish security levels and other line performance levels and select overload factors for various loading conditions. Nonclimatological load parameters i.e., broken wire, construction loads etc., will also be determined.

We will conduct a study of tower-types this will involve a preliminary review of the different types and construction materials available and the associated transportation requirements. The types considered would include rigid and guyed towers and wood-pole H-frames. The geometry of tower outlines based on electrical clearances will be developed. Based on this study, a representative range of tower types will be determined. In the event that a staged construction sequence is found to be desirable, the relative economics of double-circuit towers versus two single-circuit towers will be assessed.

Tower loads will be established. Those include average span, wind span, weight span, broken wire and stringing and maintenance requirements.

(3) Footings

Design criteria will be determined from the results of geotechnical field investigations. We would undertake conceptual designs of alternative types of footing for the family of tower types selected.

(4) Miscellaneous System Features

The conductor would be selected taking into account electrical requirements and those of mechanical strength, together with an evaluation of the losses.

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The environmental effect of audible conductor noise and RIV and TIV will also be assessed.

The basic insulation level (BIL) will be established and the type, number and configuration of insulators selected.

In the event that wood-pole construction might be selected, the possible economy of eliminating the overhead ground will also be considered.

Line hardware, the choice of arrangement for suspension, dead end and jumper assemblies will be selected. Grounding requirements will be determined and suitable arrangements for line and towers developed.

(c) Discussion

Acres has extensive experience in transmission line design for regions with cold weather climates, deep frost penetration of the ground and permafrost conditions. This will provide a solid base for developing a sound design for the various elements of the transmission system.

Optimization of the design will be assisted by our "in-house" computer program "TROP" which is a transmission optimization program. This program is supplied with the basic design requirements as input data and determines conductor sags, tensions, tower loads, voltage gradients, losses including corona, for a series of alternative situations involving variations in conductor type and size, span length and climatological conditions. On the basis of conceptual cost information, it is used in the evaluation and choice of the most economical conductor size and the optimum average span for the line analyzed.

(d) Level of Effort

Task Force (Acres) .... $ 78,500

(e) Schedule

Weeks 81 through 120

Subtask 8.05 - Substations

(a) Objective

To provide conceptual designs and cost estimates for the major terminal subtstations at each end of the system, together with typical designs for substations at the intermediate load points.

(b) Approach

From the Electrical Systems Studies (Subtask 8.02) parameters will be obtained, which will be employed in finalizing station single-line diagrams, equipment specifications and configurations, philosophy of operation and control of the substations. Early decisions will be made on whether to man the substations or depend on automatic operation with supervisory control of switching equipment.

The chosen arrangement will be reviewed to ensure that it complies with system, environmental and operational requirements. Major equipment characteristics will be determined and sketches will be produced to allow cost estimates to be prepared.

Details of the substations and switchyards will be determined and will include:

- single-line diagrams
- transformer capacity
- typical substation layouts and arrangements
- shunt reactiors (when required)
- auxiliary station service

(c) Discussion

The layout of the substations will be coordinated with the transmission line entry. For aesthetic, climatic and land management reasons, gas-insulated substation layouts will be examined. Final selection of gas-filled on conventionaly type will be made one the location of the substations is determined.

(d) Level of Effort

Task Force (Acres) .... $ 81,300

(e) Schedule

Weeks 65 through 120

Subtask 8.06 - Dispatch Center and Communications

(a) Objective

To produce a conceptual design and cost estimate for a computerized control and dispatch center that will provide reliable and secure operation of the proposed Susitna development and the Anchorage-Fairbanks transmission link. Appropriate communications will also be provided.

(b) Approach

The Susitna River Basin project will introduce considerable hydroelectric generating capacity into a predominantly thermal-electric generating system. It is also proposed to interconnect the Fairbanks area with that of Anchorage, thus developing a larger power system than the two existing at present. To make effective use of facilities in the enlarged power pool, a dispatch center with reliable communication system will be required. The studies described below will be undertaken during the feasibility stage.

- Review and previous studies related to system control and communications in the Railbelt area

- Collect data on existing communications and system control practised by the Railbelt utilities

- Meet with APA, the Alaska Power Administration and the utilities to discuss future or committed plans with respect to control centers or communication systems

- Propose a range of alternatives to achieve the goal of providing effective control of the power pool. The cost of these alternatives will be estimated and compared in a report

- Various degrees of sophistication will be examined and schedules and estimated costs for introduction will be prepared

- The question of which agency will have overall operating responsibility will be addressed

- A preferred system will be selected and conceptual designs and cost estimates prepared.

(c) Discussion

It is necessary to define overall responsibility at the beginning of this phase of the work in order to establish the criteria for choosing the most suitable scheme.

The dispatch center and a comprehensive communication system will provide the following functions:

- Real time monitoring of system conditions with continuous update
- Enhancement of system security, thus providing a reliable service
- Economic dispatch of generating facilities, both thermal and hydro
- Monitoring of transmission loads
- Economic dispatch of intertie power
- Provision of supervisory control for selected unattended substations

In our opinion, considerable advantages can be derived if the Railbelt power interconnection is operated with a centralized dispatch center and the complementing communication channels.

Arrangements will be made to enlist the services of specialized consultants such as "Energy and Control Consultants" from California to assist Acres and review this section of the preliminary report.

(d) Level of Effort

Task Force (Acres)	$ 79,000
External Consultants	20,000
Total Subtask 8.06	$ 99,000

(e) Schedule

Weeks 65 through 120

Subtask 8.07 - Transmission Line Cost Estimates

(a) Objective

To arrive at a feasibility estimate type of cost of the transmission system.

(b) Approach

Utilizing Acres experience in northern construction logistics, a capital cost estimate will be prepared for the construction of the lines. Special care will be taken to fully reflect the need to respect strict controls on construction activities, to control environmental impacts and carry out a mitigation program during and following the completion of construction.

(c) Discussion

Costs of the procurement of material and their shipment to site will be carefully evaluated by investigations and supplemented by enquiries of competent suppliers.

Acres estimates of costs for construction will be refined by the involvement of experience contractors who will be asked to provide input regarding construction logistics and schedule.

(d) Level of Effort

Task Force (Acres) .... $ 30,500

(e) Schedule

Weeks 20 through 120

TASK 9: COST ESTIMATES & SCHEDULES

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A.5.10 - TASK 9: CONSTRUCTION COST ESTIMATES AND SCHEDULES

(i) Task Objectives

To develop comprehensive, contractor-type, construction cost estimates for each major element of the recommended Susitna Hydroelectric Project, detailed engineering and construction schedules and an associated analysis of potential contingency constraints and impacts.

(ii) Task Output

The primary outputs of Task 9 will ultimately be cost estimate summary reports and construction schedules appropriate for inclusion in Task 10, FERC Licensing documentation. The final versions of these documents will be submitted for review and approval by Alaska Power Authority on or about Week 126 of the Study. These documents will be suitable for continuous updating and/or modifications during the subsequent study period through commencement of construction and for use in preparation of Engineer's estimates during the construction and equipment supply contract bidding phases of the project.

Preliminary cost estimates and schedules will also be the subject of design transmittals issued on or about Week 60 of the Study for inclusion in the Development Selection Report under Task 6.

(iii) List of Subtasks

Subtask 9.01 - Assemble Cost and Schedule Data
Subtask 9.02 - Prepare Preliminary Cost Estimates
Subtask 9.03 - Prepare Cost Estimate Update
Subtask 9.04 - Develop Engineering/Construction Schedule
Subtask 9.05 - Perform Contingency Analysis

(iv) Subtask Scope Statements

The primary purpose of Task 9 is to provide the basis for more detailed planning, marketing and financing of the Susitna Project during the period following submission of the FERC License Application through commencement of construction. The development of these estimates and schedules prior to license submission and the relationships between Task 9 and other task activities are illustrated in the Master Schedules, Plates A7.1 and A7.2. This portion of the study will essentially be divided into two parts. The initial part of Task 9 activities will be used to establish the information systems and basic mechanisms necessary to develop the cost estimates and schedules for selection of the optimum Susitna development. The second part of Task 9 activities will essentially be devoted to the incorporation of more up-to-date information and approprite revisions of the estimates and schedules prior to submission of the FERC License Application. For ongoing cost estimating and scheduling purposes, a continuous exchange of information will be necessary with Task 2 - Surveys, Task 5 - Geotechnical

Exploration, Task 6 - Design Development, Task 7 - Environmental Studies and Task 8 - Transmission activities.

For purposes of the current Plan of Study, development of Task 9 activities has been based on the assumption that the optimum Susitna development will comprise dams at Watana and Devil Canyon and associated structures. This development is essentially the same as that recommended by the Corps of Engineers in its 1979 Supplemental Feasibility Report.

Subtask 9.01 - Assemble Cost and Schedule Data

(a) Objective

Assemble Alaska-based and national cost and schedule data appropriate to construction of large hydroelectric projects.

(b) Approach

Input to the activities of Subtask 9.02 will commence with the following preliminaries:

- Identify required project labor, material, and equipment (construction and permanent) categories
- Assemble cost and scheduling data including Alaskan and national labor, materials and equipment (construction and permanent), taxes, insurance, finance charges, other indirect costs, and delivery items
- Identify and assemble facility operating costs

On the basis of parallel Task 6 design development studies, appropriate construction activities will be identified together with construction method plans and diagrams for temporary site installations.

(c) Discussion

Earlier studies related to alternatives and development of an optimum Susitna development will have been undertaken on the basis of conceptual engineering-type cost estimates. These estimates will essentially be developed from previously published reports and available Corps of Engineers or other source data. Establishment of reliable costs and schedules for the recommended Susitna Development will however be based on a much more basic approach.

A computerized data base will be established which will be made available for use and further development during all subsequent cost estimating and scheduling activities.

(d) Level of Effort

Task Force (FMA) $10,000
Task Force (Acres) 10,000

Total Subtask 9.01 .... $20,000

(e) Schedule

Weeks 70 through 75

Subtask 9.02 - Prepare Preliminary Cost Estimates

(a) Objective

Prepare preliminary, construction-type construction cost estimates for the Susitna Hydroelectric Project.

(b) Approach

Preliminary cost estimates will be prepared for:

- Site access arrangements
- Permanent camp facilities
- Watana Dam and associated works
- Devil Canyon Dam and associated works
- Transmission facilities
- Reservoirs and related facilities

These estimates will be based on reviews of previously published reports of the Susitna development, appropriately modified and updated in the light of such reviews. Lists of construction pay items and quantity estimates will be prepared for appropriate construction activities.

Unit and/or lump sum prices will be developed and assembled for appropriate pay items, including all direct and indirect costs, and total facility investment and operating cost estimates.

(c) Discussion

The results of this activity will provide the input into ongoing Task 6 - Design Development activities. Although these data may be subject to modification during later stages of the study when further drilling and testing information becomes available, the groundwork laid at this time will form the basis of all further costing activities to be performed.

(d) Level of Effort

Task Force (FMA)	$ 2,000
Task Force (Acres)	20,000
Total Subtask 9.02	$22,000

(e) Schedule

Weeks 73 through 78

Subtask 9.03 - Prepare Cost Estimate Update

(a) Objective

Prepare updated, comprehensive, construction-type, construction cost estimates for the Susitna Project for inclusion in FERC License Application.

(b) Approach

Preliminary cost estimates prepared under Subtask 9.02 will be updated and modified for incorporation in the FERC License Application documents.

Construction methods, scheduling and cost studies already performed under Task 6 studies will be further developed and expanded under this subtask. The accuracy of construction costs will be improved by application of updated information, including:

(1) Site costs for labor, materials, equipment and fuel

(2) Installation procedures to be adopted for each project component; construction methodology for the dams, spillways and power plants

(3) Detailed construction schedule and resource allocation for each project component and the total project

(4) Site development requirements for power, access, transport, construction materials, water, and support facilities

(5) Technical and economic analysis for concrete manufacture, borrowed fill, quarries and disposal of excavated materials

(6) Construction manpower schedules

(7) Mechanical and electrical equipment price variation due to escalation and market pressures

(8) Short and long-term interest rates and cost escalation assessments

(9) Detailed list of pay items and quantity take-offs

(10) Detailed construction cost estimates, including unit prices, directs, indirects, contingencies, interest during construction and administration, cash flow diagram

Project engineering designs and preliminary equipment specifications prepared under ongoing Task 6 activities will serve as the baseline for each cost estimate. A standard estimating format will be adopted and sound accounting practices will be followed to separate direct costs, indirect costs and capital expenses. All costs will be tabulated into natural division that lend themselves to the application of the FERC code of accounts for hydropower projects.

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Detailed quantity take-offs will be prepared from the project engineering drawings to support permanent material cost estimates. Consumable materials will be estimated using known rules-of-thumb and accepted unit rates.

Updated labor estimates will be prepared in conjunction with the scheduling effort. Typical project labor agreements will serve as a basis for these revised estimating costs. Rates of productivity, as dictated by the schedule and tempered by the Alaskan climate and work force, will be established for each type of work.

More realistic plant and equipment costs will be estimated using actual experience gained from similar work performed in Alaskan environments.

Indirect costs will be estimated based upon a number of factors, including total construction time, numbers of craft labor, length of shifts, volume of subcontracted work, etc. Finally, a cost escalation factor will be applied to each cost estimate to account for increases in labor and material costs throughout the life of the project.

(c) Discussion

The estimated cost of construction will be a key factor in establishing feasibility and licensing as well as financing of the project. Estimating construction costs in Alaska presents some unique factors and situations that can only be dealt with through practical experience at the field level. The Acres/Moolin team provides senior individuals with a wealth of experience of large hydroelectric developments in cold climate regions and with specific Alaskan construction experience. Input and review of all cost estimates by these personnel will ensure the reliability of the estimates.

Some of the unique problems that must be accounted for include:

- A relatively inexperienced labor force
- Unusual environmental/weather constraints
- High level of government surveillance/interaction
- Low equipment productivity during cold weather
- High freight costs for materials/spare parts

(d) Level of Effort

Task Force (FMA) $16,000
Task Force (Acres) 53,000

Total Subtask 9.03 .... $69,000

(e) Schedule

Weeks 110 through 126

Subtask 9.04 - Develop Engineering/Construction Schedule

(a) Objective

Develop integrated engineering, construction and equipment installation network logic diagrams and bar chart schedules, optimize resource allocations, and perform analyses to identify probable critical path for construction of the Susitna Hydroelectric Project.

(b) Approach

The engineering, construction and equipment installation network will be established and updated on the basis of parallel Task 6 design development studies. A consolidated construction schedule will also be prepared to identify major construction activities and their required start and finish dates in bar chart format. Determination of the critical path will be accomplished by means of an appropriate computerized mathematical model which will facilitate later updating requirements. The proposed model will be that described in Part C3 of this proposal, or similar.

The critical path analysis will show duration, early start date, late start date, early and late finish dates, float and zero float critical path for all major activities.

Preliminary scedules will initially be prepared as input to the Task 6 Development Selection Report and subsequently further developed and modified for inclusion in FERC licensing documents under Task 10.

As discussed in Section A6, it is proposed that prior to commencement of construction of the Susitna Project a Program Planning Guide will be prepared. This guide will identify for Alaska Power Authority management the specific planning requirements for the project. It will also provide, for the eventual project management group, those products essential to the planning and management of the development.

(c) Discussion

The basic ground work for the key elements of the Project Planning Guide will be performed under this subtask. Senior level personnel from the Acres/Moolin team will initiate the development of the specific elements that will be required for planning and management of the project. Experience gained on other "giant" projects such as the Churchill Falls Development, and the prepration of similar planning guides (Moolin has recently completed the Project Planning Guide for the Alaska Gasline) will serve as a basis for the task.

It is apparent in the industry that sponsors of giant projects are beginning to recognize the importance of first developing a program planning guide for the management of these projects. We feel this type of planning can best be done by a relatively small number of senior level, highly qualified individuals. This small group of personnel, selected because of their first-hand experience in managing and planning other projects, is in the best position to understand and convey the problems associated with giant projects.

As the size of the project increases, especially those in remote areas where a greater dependence upon outside support is required, so does the number and complexity of the interfaces between the various elements of the project. It will be up to the planning team to concisely and completely define the additional level of input required for successful advancement of the project.

(d) Level of Effort

Task Force (Acres) $35,000
Task Force (FMA) 20,000

Total Subtask 9.04 .... $55,000

(e) Schedule

Weeks 73 to 126

Subtask 9.05 - Perform Contingency Analysis

(a) Objective

Investigate potential contingencies/risks and to evaluate their effects upon cost estimates and schedules.

(b) Approach

A preliminary assessment will be made for each aspect of the cost estimate and construction schedule to examine potential risks involved in terms of cost escalation and/or schedule slippage. Sources of risk will be considered both individually and collectively, and their potential impacts determined. From the results of the risk analysis optins, fall back position and contingency plans will be developed.

The results of this study will provide input to risk analyses to be performed under Task 11.

(c) Discussion

There are a number of contingencies that can have adverse effects upon the project, each of which must be analyzed. They include the following:

- The selected thin arch or other design for the Devil Canyon Dam may not stand up to further seismic testing. This may require a change in design, thus requiring new cost and schedule estimates.
- Unforeseen foundation problems (unstable bedrock, permafrost, etc.) discovered during the POS and/or initial construction phases may lead to a requirement for deeper excavation or extensive confined excavation procedures.
- Unexpected flooding conditions, due to the size of the watershed involved, can have a significant impact upon costs.
- Unusually restrictive environmental conditions imposed by governmental agencies can have significant impacts. Large projects in Alaska have a history of attracting an unusually high involvement by the agencies that cannot be ignored.
- Unforeseen inclement weather may reduce the already short Alaskan construction season and force scheduled events into unfavorable weather conditions. Also, poor weather may require the use of special heated enclosures to allow the work to progress.
- Unexpected river icing conditions may require changes in design and/or constructin of unplanned structures to contend with winter ice forces and spring breakup conditions.

(d) Level of Effort

Task Force (Acres)	$13,000
Task Force (FMA)	6,000
Total Subtask 9.05	$19,000

(e) Schedule

Weeks 115 through 126

TASK 10: LICENSING

A.5.11 - TASK 10: LICENSING

(i) Task Objectives

To provide for timely preparation and assembly of all documentation necessary for application for license to the Federal Energy Regulatory Commission (FERC).

(ii) Task Output

The output from this task will be a completed application for licensing the Susitna Hydroelectric Project. This completed package, including exhibits A through W (less P and Q, which are not required for licensing a major hydroelectric project) will be prepared for final review by external review panels and by APA on or before the end of the 128th week of the study period, with earlier preliminary design transmittals having been assembled and reviewed in-house and by APA upon substantial completion of significant individual exhibits.

(iii) List of Subtasks

Subtask 10.01 - Impact of New FERC Regulations

Subtask 10.02 - Establish Regulatory Requirements

Subtask 10.03 - Data Acquisition from Others

Subtask 10.04 - Coordinate Exhibit Preparation within Major Task Categories

Subtask 10.05 - Prepare Exhibits D and E

Subtask 10.06 - Prepare Exhibit R

Subtask 10.07 - Prepare Exhibit T

Subtask 10.08 - Prepare Application Form

Subtask 10.09 - Documentation Review and Deficiency Correction

Subtask 10.10 - External Review, Client Execution, and Filing

(iv) Subtask Scope Statements

Assuming that technical and economic feasibility are found and that environmental impacts and proposed mitigatory actions are acceptable, the major target toward which all other work is aimed is the successful completion of a license application to FERC. Indeed, this entire Plan of Study has been prepared in such a manner that only those tasks and subtasks considered to be the minimum necessary for acceptance by FERC of the license application are included in the first 30 months. To be sure, a significant amount of follow-on work must necessarily be accomplished prior to eventual construction, but the historically lengthy periods associated with federal processing of applications clearly suggest that the earliest possible submission is in the best interest of the Power Authority. This latter observation was confirmed, during preparation of this Plan of Study, by Mr. Ron Corso, FERC, whose comments on the matter are summarized in Annex A to Task 10. Briefly stated, Mr. Corso assures us that it is entirely appropriate--even advisable--to file an application which meets minimum requirements for submission while at the same time detailing plans for initiation or continuation of studies whose results may be required before the license itself is actually awarded. It will be noted in Annex A that new regulations will probably change the letter designation of various exhibits and will combine many into single packages. For purposes of clarity in succeeding subtasks, we have chosen to refer to the production of exhibits in terms of the titles which currently officially apply.

There is a complication associated with the preparation of this task package. The current applicable FERC regulations are now under revision, and there is little doubt that they will be in force prior to that time we have proposed for filing. The most likely form of the new rules, we are given to understand, will be essentially the same as is now required, but there will be some effort made to streamline and expedite processing as well as simplify procedures. Aside from Subtask 10.01, all remaining subtasks have been prepared to conform to the regulations as they now stand. Subtask 10.01 itself provides for review, assessment, and, if necessary, adjustments associated with new regulations if and when they become effective. Subtask 10.02 establishes a complete listing, together with actions and responsible project personnel for compliance with all regulatory requirements, including, if appropriate, any new regulations which become effective during the course of the study.

The basic application must be made in accordance with a prescribed format and must be accompanied by a series of exhibits, each of which must meet certain criteria as detailed in the regulations. Table 1, Task 10, summarizes exhibit content and shows those points at which the output from other Tasks contributes to preparation or actually furnishes individual exhibits. The last column of that table summarizes certain work to be accomplished in Task 10. It will be noted that the exhibits may be generally broken down into three categories:

(1) Those exhibits which must be acquired from sources external to the Acres' team. State laws, for example, fall in that category. Subtask 10.03 provides for data acquisition from others.

(2) Those exhibits which will be outputs from other tasks, prepared by various members within the Acres' team. Subtask 10.04 accounts for monitoring and coordinating this type of exhibit.

(3) Those exhibits and the application form itself which must be prepared based upon data produced in other tasks or developed from other sources. Subtasks 10.05 through 10.08 cover necessary activities.

Subtasks 10.09 and 10.10 account for the often arduous and frequently time-consuming process of essential review, both in-house and by external panels, as well as final execution and filing.

Subtask 10.01 - Impact of New FERC Regulations

(a) Objective

Review draft and final versions of new FERC regulations to be issued in the near future; prepare revisions to subtask work statements as appropriate; and assess cost and schedule impacts for consideration by the Power Authority.

(b) Approach

Immediately upon publication of proposed new regulations, a careful review will be conducted to identify changes which must apparently be addressed. Comments will be prepared, if appropriate, to ensure that any apparent ambiguities are resolved and to recommend changes, particularly insofar as they might favorably and reasonably facilitate compliance. A comprehensive list of actions will be drawn up and responsibilities for implementation within the Acres' team will be assigned to appropriate project personnel by name. Subtask work statements will be revised as necessary. To the extent that changes--increases or decreases--in estimated costs and schedules appear necessary, a report will be made to the Power Authority, along with recommendations as to how best to proceed. Once proposed regulations have been through the review process and are published as final, any necessary further iterations of the above activities will be accomplished.

(c) Discussion

As a matter of policy, we continuously monitor activities of the FERC, for there is much to be learned from the experience of Acres and others in recent past and ongoing application processing. A necessary part and parcel of this monitoring effort is, of course, associated with development of regulatory changes and of new or innovative interpretations and decisions on existing ones. Thus do we know with certainty that new proposed regulations are imminent. Indeed, we have already received some initial advice from Mr. Ronald Corso, Deputy Chief, Division of Licensed Projects, FERC (see Annex A to Task 10). We have been led to believe that no major substantive changes for major hydroelectric projects are likely, and we therefore have some confidence that the remaining subtasks in this major Task are valid. Even so, it is prudent to provide for comprehensive review of any change, for even a variation of one tenth of one percent on a multibillion dollar project can produce millions of dollars worth of new requirements. The matter of preparing action lists and designating responsible individuals is one we regard as essential to the management of all phases of this giant project. It is fully in keeping with our earlier announced intent to accomplish all those things which are necessary for successful filing and to provide for initiation or continuance subsequent to filing for all those additional activities required for actual award of a license and, beyond that, for eventual project construction.

(d) Level of Effort

Task Force (Acres)..	$9,000
Liaison and Coordination by APA (included under Subtask 13).....	--
Total Subtask 10.01..	$9,000

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(e) Schedule

Upon publication of proposed draft regulations.

Subtask 10.02 - Establish Regulatory Requirements

(a) Objective

Identify all regulatory requirements to be satisfied as a condition for licensing and provide for compliance.

(b) Approach

All statutes, rules, regulations, and other requirements directly or indirectly affecting the process of investigating and subsequently constructing the proposed project will be reviewed and a design transmittal will be prepared setting forth the steps which will be required for compliance. Specific action responsibilities will be assigned to members of the Acres' team. Some of the federal statutes having significant impact on the project--and therefore to be reviewed under this subtask--include:

- Federal Water Power Act of 1920
- National Environmental Policy Act (P.L. 91-190)
- Fish and Wildlife Coordination Act (P.L. 85-624)
- Endangered Species Act (P.L. 930205)
- Historical Preservation Act (P.L. 89-665)
- Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500)
- Anadramous Fish Act
- Wilderness Act (P.L. 88-577)
- Wild and Scenic Rivers Act (P.L. 90-542)
- Coastal Zone Management Act (P.L. 93-612)
- Federal Land Policy and Management Act of 1976 (P.L. 94-579)
- Fuel Use Act of 1978
- Alaska Native Claims Settlement Act of 1971 (85 Stat. 706)

Rules, regulations, and procedures for permits are imposed as well under the laws of the State of Alaska. Some of the Departments and Agencies having direct responsibilities or significant interests within the State include:

- Department of Fish and Game
- Department of Economic Development
- Department of Commerce
- Department of Natural Resources

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- Department of Environmental Conservation
- Department of Community and Regional Affairs
- Department of Labor
- Alaska Growth Policy Council
- Alaska Historical Commission
- Capital Site Planning Commission
- Land Use Planning Commission of Alaska
- Department of Public Safety
- Department of Transportation and Public Facilities

In addition, requirements which may be imposed by municipalities and boroughs (particularly insofar as transmission routes are concerned) and by Native organizations who will eventually acquire title to lands in and around the project area will be identified, analyzed; and plans will be drawn up for compliance.

Services will be requested from the Alaska Department of Law for assistance in identifying and interpreting applicable State and local regulatory requirements. Estimated costs for the appropriate level of effort are included in subparagraph (d) below. In the event that the Department of Law cannot assist, an Alaskan law firm will be engaged for consultation on these matters.

(c) Discussion

As may be noted from the incomplete listing of federal laws and state and local interests above, there will be a decidedly complex web of permits and procedures to be satisfied. It is all the more important, then, to devote time and attention early in the study effort to ensure compliance. Indeed, some of the various permitting procedures provide opportunities for public notice and comment and, on occasion, for public meetings or hearings. Time requirements tend to be lengthy in such cases, and the process cannot begin until application is made. Much of the effort involved in completion of this subtask will contribute to the work involved in other subtasks. Subtask 10.05, for example, provides for preparation of Exhibit D, wherein evidence of compliance with State laws must be provided. It follows that identification of appropriate laws and describing procedures for compliance are important first steps as well as convenient check lists for the provision of evidence of compliance.

(d) Level of Effort

Task Force (Acres)...........................	$25,000
Legal Consultation* from the Alaska Department of Law and/or Alaskan law firm..	10,000
Total Subtask 10.02	$35,000

(e) Schedule

Weeks 3 through 12 and intermittently thereafter throughout the study period.

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*Legal consultation on applicable federal laws will be provided by Mr. Charles McCarthy, Esq., a Director of Acres and a long-time practitioner and expert before the former Federal Power Commission and the current Federal Energy Regulatory Commission.

Subtask 10.03 - Data Acquisition from Others

(a) Objective

Provide for coordinating the preparation and collection of data to be provided by various parties external to the Acres' team and to assemble those exhibits for which no other input is required from the Acres' team.

(b) Approach

Exhibits A, B, and C generally require that certain copies and certifications be provided. In each case, these documents are available from, or must be produced by, others. We will request the necessary items and review them for adequacy insofar as FERC requirements are concerned. In the event that deficiencies are noted, further efforts will be undertaken to assure they are corrected. Once the necessary documentation is received and found to be adequate, completed exhibits will be assembled and made available for preliminary review. Subsequent reviews will occur under subtasks 10.10 and 10.11. For purposes of task analysis, we assume that the actual license applicant will be the State of Alaska. Certain specific items and sources are noted below:

(1) For Exhibit A, copies of the laws under authority of which the application is made.

(2) For Exhibit B, copies of all minutes, resolutions of directors of the Power Authority, as well as any pertinent legislative proceedings and executive decisions substantiating authority to file the license application.

(3) For Exhibit C, copies of special hydroelectric, water power, or irrigation laws of the State. Note that this information will already have been assembled under Subtask 10.02, so that the only additional requirement under this subtask is to review for completeness and assemble as an exhibit.

(c) Discussion

Although the level of effort associated with this subtask is minimal, it has been included to ensure that every item required under FERC regulations is included.

(d) Level of Effort

Task Force (Acres).....................$1,000

(e) Schedule

Weeks 12 through 16

Subtask 10.04 - Coordinate Exhibit Preparation within Major Task Categories

(a) Objective

Ensure that outputs from various tasks are consistent with FERC requirements pertaining to applicable exhibits.

(b) Approach

FERC regulations will be reviewed in detail to identify specific products, along with their specifications, to be developed as outputs from other tasks within this Plan of Study. Criteria will be prepared and distributed to appropriate responsible individuals. Progress will be monitored throughout the course of the work and design transmittals will be reviewed in each case to ensure consistency with current--and to the extent that changes occur, future--FERC regulations. Complete exhibit packages will be prepared for Exhibits F through O, S and U through W. As noted in Table 1, Task 10, each of these products is a required output from another task.

(c) Discussion

This subtask provides for positive controls to ensure that the work produced in other tasks will, in fact, be available for use without further modification (except, perhaps, for certain introductory materials and tables of contents) as exhibits in the application package. Certain very specific criteria for dimensions, degree of detail, drawing content, and the like must be identified at the start to avoid costly abortive efforts and/or redundant work.

(d) Level of Effort

Task Force (Acres)...................... $56,000

(e) Schedule

Throughout project period.

Subtask 10.05 - Prepare Exhibits D and E

(a) Objective

Acquire and evalute data incident to preparation and prepare exhibits D and E.

(b) Approach

Exhibits D and E are sufficiently closely related that concurrent work on both is justified.

Exhibit D calls for evidence of compliance with requirements of the laws of the State of Alaska with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes and with respect to the right to engage in the business of developing, transmitting, and distributing power, and in any other business, necessary to effect the purposes of the license applied for, including a certificate of convenience and necessity, if required. This evidence shall be accompanied by a statement of the steps that have been taken and the steps that remain to be taken to acquire franchise or other rights from the State, boroughs, and municipalities before the project can be completed and put into operation.

Exhibit E requires a description of the nature, extent, and ownership of water rights in the development of the project, together with satisfactory evidence that the applicant has proceeded as far as practicable in perfecting its rights to use sufficient water for proper operation of the project works. A certificate from the proper State agency setting forth the extent and validity of the applicant's water rights shall be appended if practicable. In case the approval or permission of one or more State agencies is required by State law as a condition precedent to the applicant's right to take or use the water for the operation of the project works, duly certified evidence of such approval or permission, or a showing of cause why such evidence cannot be reasonably submitted shall also be filed. When a State certificate is involved, one certified copy and the required additional uncertified copies shall be submitted.

It will be recalled that Subtask 10.02 seeks to identify applicatory laws and regulations as well as to plan a program for compliance. In this subtask, we will monitor the compliance program to ensure that it is being fulfilled. A report will be prepared setting forth the steps taken to the point of application as well as a description of further programs leading to eventual total compliance. Although application for license filed by the State implies that State law has itself been complied with, we will nonetheless take suitable measures to make known our compliance efforts. Thus will Exhibit D be prepared.

We will seek the assistance of the Alaska Department of Natural Resources in providing a definitive certificate of the extent and validity of the State's water rights. In the event that water use conflicts are discerned (and they very well may be, for current authorities to reserve water for various uses are complicated or vague where they exist at all) they will be documented and evaluated. A report detailing the results of our own research on the water rights issue together with appropriate certification by the Department of Natural Resources will become Exhibit E.

We intend to provide draft copies of proposed Exhibits D and E to various State agencies under whose auspices regulatory and legal requirements are monitored or enforced. The earliest coordination of these items will contribute significantly to our ability to fairly represent our efforts to ensure understanding and compliance.

(c) Discussion

It is important to note that the issues of compliance with state law, and particularly of water rights, will be addressed in various public meetings, for it is in those forums that public perceptions of potential conflict are most likely to surface. In addition, workshops to be conducted under the public participation program (Task 12) are designed to seek involvement of interested and affected State agencies while the work goes on rather than present them with a fait accompli at the end of the 30-month study effort.

Late in the development of this Plan of Study, we received a letter and a proposal from the Alaska Department of Natural Resources (DNR) suggesting their participation in the assessment of instream flow requirements and noting DNR's ongoing efforts toward resolution of water use conflicts in Alaska. We had earlier anticipated the need to undertake the hydrologic work suggested therein and have generally accounted for it in various subtasks within Task 3, Hydrology. Even so, we will review the manner in which our own scheduled data collection efforts compare with DNR's in terms of both technical adequacy and estimated costs. Should that review demonstrate clear advantage to the State by following the DNR program, we are prepared to do so. In this latter event, we would seek an arrangement whereby DNR is engaged directly by the Power Authority to avoid any conflicts of interest and to ensure as well that water use and compliance certification at a later point is shown to be objective and legally sufficient.

(d) Level of Effort

Task Force (Acres)...................... $27,500

(e) Schedule

Weeks 12 through 24 and 100 through 116.

Subtask 10.06 - Prepare Exhibit R

(a) Objective

Acquire and evaluate data incident to preparation and prepare Exhibit R - Recreation.

(b) Approach

We will seek to determine the interests and desires of the public insofar as recreation is concerned through the public participation program. The particular views of owners and residents who may be affected will be sought. Certainly, for example, Native organizations whose lands lie within or adjacent to project boundaries and residents within the river basin--particularly downstream--are especially important.

We will consult with the Department of Interior, the Power Authority and interested State Agencies on a continuing basis, and particularly during the eight scheduled workshops described in Task 12, Public Participation.

Three alternative concepts will be drawn up, one of which considers strictly controlled access and purposeful avoidance of man-made recreational features. These concepts will be available for review by the end of the 11th month so that they can be presented at the second public meeting to be held early in 1981. Environmental impacts will be evaluated as a portion of the work to be accomplished under Task 8 - Environmental Studies.

That alternative which appears to best satisfy the public interest, after a careful evaluation of all factors, will be presented for consideration at a workshop in May 1981. Modifications will be made as appropriate and a revised recommended concept will be presented at a workshop in September '81. A final conceptual recreational plan will then be developed in the detail required by FERC regulation for preparation of Exhibit R.

(c) Discussion

It will be noted that environmental studies conducted during Task 7 provide for the development of a rigorous final recreation plan during the post-license application phase. The conceptual plan prepared under this subtask will provide a basis for proceeding with that work. Should significant changes to the original concept be indicated, supplementary reports will be provided to FERC as the final plan emerges.

It is extremely unlikely that total concensus will be achieved on any single recreational concept. Indeed, it is probable that the spectrum of desires will range from no recreational development and strictly controlled access to a Disneyland North. It follows that the evaluation and selection process for a single recommended plan should be understandable and should, insofar as is possible, best balance environmental concerns, desired developments, and economic factors. In any case, we do not intend to assign a specific value to recreation in order to boost what might otherwise be an economically unjustifiable project into a seemingly attractive marginal development. Indeed, where private financing is sought, it will be achieved or denied on the basis of power benefits alone.

Consultation with various federal agencies will also be required in view of current federal interests in all project lands and expected continued federal interest in portions of the project area, including certain access routes and transmission routes.

(d) Level of Effort

Task Force (Acres).......................$95,000

(e) Schedule

Throughout project period.

continued federal interest in portions of the project area, including certain access routes and transmission routes.

(d) Level of Effort

Task Force (Acres).....................$95,000

(e) Schedule

Throughout project period.

Subtask 10.07 - Prepare Exhibit T

(a) Objective

Acquire and evaluate data incident to preparation and prepare Exhibit T--Statement of Reasons for Non-Federal Development.

(b) Approach

The reasons why development of the project by the State of Alaska rather than by the Federal Government is in the public interest will, of course, have been debated at length within the State prior to the decision to select a consultant to undertake the proposed work. We will review the minutes and transcripts of those meetings and sessions which led to that decision with a view toward expressing the reasoning in a formal report. Any additional light which may be shed on the matter as a result of public participation will be included as well. We will also seek the views of the Chief of Engineers, U.S. Army Corps of Engineers, since federal development would be accomplished by the Corps of Engineers if the State chooses not to use a consultant to accomplish the work.

After a selected development plan has been developed, cost estimates and schedules have been prepared, financial planning and risk analysis have been essentially completed, and environmental impacts assessed, we will attempt to discern differences--both positive and negative--which deserve to be addressed in Exhibit T. A final report to serve as Exhibit T will be prepared upon completion of the last public meeting in April 1982.

(d) Level of Effort

Task Force (Acres)....................$25,000

(e) Schedule

Weeks 1 through 12, 122 through 125, with intermittent activities at other times.

Subtask 10.8 - Prepare Application Form

(a) Objective

Prepare application in prescribed format.

(b) Approach

The prescribed format for license application requires brief summaries of data which is contained in detail in the exhibits. We will prepare this document in draft form upon substantial completion of the various exhibits. An initial legal review will be accomplished at this time.

(c) Discussion

Although this task becomes relatively simple once all exhibits have been prepared, it is nonetheless extremely important, for the summary application form will be far more widely read than the detailed documentation which accompanies it.

(d) Level of Effort

Task Force (Acres).........................$5,000

(e) Schedule

Week 126

Subtask 10.09 - Documentation Review and Deficiency Correction

(a) Objective

Provide for final in-house review of draft license application.

(b) Approach

Whereas continuous reviews will have been conducted throughout the study period as individual subtasks are completed and various design transmittals and draft exhibits are offered for comment, we propose to conduct an exhaustive in-house review of the recommended final license application. A full two weeks will be set aside for this purpose and our designated in-house review panel will individually review and collectively meet to consider the proposed final draft application. Deficiencies will be corrected wherever they are found to occur. After the first week of the two week review period, copies will be made available for final review by the expert external boards established for the purpose. That effort is covered under Subtask 10.10.

(c) Level of Effort

Task Force (Acres) $35,000

(d) Schedule

Weeks 127 and 128.

Subtask 10.10 - External Review and Client Execution

(a) Objective

Provide for final review by external boards and for final production of application ready for filing.

(b) Approach

External board members will be provided final draft copies of the proposed application three weeks before targeted completion date. Reviews will be conducted individually for approximately one week, and the boards will convene during a second week to permit discussion of concerns, if any. Members of the Acres' team will be made available as necessary upon request to answer questions. To the extent that correctable deficiencies are discovered at any time during the review period, immediate action will be taken to alleviate the problem. For that purpose, a representative from the Acres' team will be made available to the board for liaison and review throughout the two-week review period.

The final week of the study period will be devoted to final correction, production, and delivery of the application for execution and filing by the State.

(c) Discussion

The proposed careful review will serve several purposes. Firstly, it is clearly important on a project of such magnitude to avail oneself of the best available opinion as to the adequacy of the work. Secondly, the collective efforts of eminent review groups may serve to reduce the challenges or interventions which may be made during the license processing period. Certainly, members of the external board may also be called as expert witnesses during later periods. Thirdly, the vital confidence of potential investors will surely be bolstered by the thoughtful deliberations of such an august body.

(d) Level of Effort

Task Force (Review Panels)......................	$50,000
Liaison, coordination, correction (Acres).......	5,000
Total Subtask 10.10	$55,000

(e) Schedule

Weeks 128 through 130

ANNEX A TO TASK 10

SUSITNA HYDROELECTRIC PROJECT

P5477.15

NOTES ON MEETING
At Federal Energy Regulatory
Commission, Washington, D.C.
August 3, 1979

PRESENT:

Mr. Ronald A. Corso, Deputy Chief, Division of Licensed Projects, FERC

Dr. E. L. Baum, Vice President, Acres
Mr. J. D. Lawrence, Project Manager, Acres

The meeting was held at the request of Messrs. Baum and Lawrence to discuss the proposed amendments to Federal regulations for licensing "major" projects (greater than 1.5 MW) at previously undeveloped sites.

Mr. Corso indicated that the new regulations were scheduled for issue in draft form in late August, but made the following comments and suggestions for consideration as guidelines in the preparation of an FERC license application:

(1) The format of the revised regulations would be similar to those issued for major projects at existing dams (Docket No. RM79-36: see summary of revised regulations, Attachment A)

(2) The emphasis in the new regulations will be on simplification of documentation to the greatest extent possible and the earliest possible involvement of FERC and other concerned regulatory agencies in resolving the issues which may be raised.

(3) The attachment dealing with "Need for Power", which will deal with load forecasting, the economic role of the project in the system, and alternatives, will be vital. This section will be critically reviewed by FERC and should therefore be as complete as possible when the application is submitted.

(4) The attachment dealing with geotechnical information should provide summary results of all exploratory work undertaken for conceptual designs, sufficient to demonstrate the technical and economic feasibility of the project. This information need not necessarily be exhaustive at the time of submission of the application: it is recognized that additional geotechnical exploration will usually be required prior to commencement of construction. Such information should be provided as and when requested by FERC during processing of the application.

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(5) Exhibit D should essentially be a one or two page summary only. More detailed summaries in the FERC accounts format should be provided as an attachment: it is recognized that these estimates will be updated as additional information and designs are developed. Such updated estimates should be submitted as and when requested by FERC during processing of the application.

(6) The attachment dealing with flood analysis and routing, and structural stability analyses (including comprehensive treatment of seismic/earthquake considerations) must accompany the application and should demonstrate the safety of the project.

(7) Exhibit E will now encompass the original Exhibits H, I, R, S, V and W. It should essentially be a brief summary report, accompanied by the necessary detailed attachments to provide the requisite data for preparation of an EIS. It is recognized that this information may not be exhaustive when the application is submitted. The attachment should provide evidence that the environmental issues have been identified, that adequate action is being taken to establish base-line conditions, that preliminary assessments have been made and possible methods of mitigation explored within the constraints of the available data, and that approved plans for continued monitoring of base-line conditions and processing of data have been instituted. This evidence should include copies of correspondence with all concerned federal, state, and local agencies and individuals affected by the project, and copies of approved plans. Additional information obtained as a result of ongoing studies should be submitted as and when requested by FERC during processing of the application and preparation of the EIS.

(8) Design drawings for inclusion in the license application need only be conceptual. Final bid drawings and specifications for project construction should be submitted prior to commencement of construction, as and when required by the FERC.

(9) Specific issues pertinent to the Susitna Project license application, which will require attention are:

(a) The problem of thermal stratification of the reservoir will probably require thermal modelling (<u>after</u> submission of application) and designs for multi-level intakes.

(b) Hydraulic modelling of spillways and potential erosion problems will probably be required (<u>after</u> submission of application).

(c) There may be advantages in addressing the licensability of the transmission line intertie separately from the hydroelectric project. This might avoid the possibility of problems arising in one area of concern causing unnecessary delays in the other.

(d) FERC will evaluate the project on the basis of power benefits alone. Evaluations of multi-use benefits are probably suspect and difficult to rationalize.

(e) If ADF&G were to enter into a contractual relationship with Acres for performance of certain portions of the environmental work, they would be precluded by FERC as potential intervenors for any issues arising from that work. It would therefore not be in the interests of ADF&G to enter into such relationships.

ATTACHMENT A

REVISED FERC REGULATIONS FOR LICENSES FOR MAJOR PROJECTS

New Regulations		Old Regulations
Exhibit	Content	Covered by Exhibits Shown
-	Initial Statement	A,B,C,D,E,F
A	Project Description	M
B	Resource Utilization Statement	H,I,T,U
C	Construction Schedule	O
D	Costs & Financing Summaries	G, N
E	Environmental Report	H,I,R,S,V,W
F	Design Drawings	L
G	Project Map	J,K

Attachments:
- Demonstration of Need for Power
- Geotechnical Information
- Detailed Cost Estimates
- Spillway Flood and Structural Stability Analyses
- Detailed Environmental Report

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TABLE 1 - TASK 10

FERC LICENSE APPLICATION: EXHIBITS

Exhibit	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
A	Charter or certificate and article of incorporation of applicant.	13	10	Acquire copies of state laws under which the application is made.
B	Certified copy of resolutions of stockholders and/or directors authorizing application.	13	10	Secure data from APA regarding minutes, resolutions of the authorizing application.
C	Copies of State laws pertaining to construction of the project.	13	10	Acquire copies of special hydro-electric, waterpower, or irrigation laws of the State of Alaska.
D	Evidence of applicant's compliance with requirements of State laws pertaining to use of lands and water for the project.	2, 11, 12, 13	10	Prepare statement of steps that have been taken and that remain to be taken.
E	Ownership, extent and nature of water rights applicant will use and evidence of applicant's plans for perfecting its rights to use the water for operation of the works.	2, 3, 6, 12, 13	10	Acquire certificate from Alaska Department of Natural Resources regarding water rights.
F	Statement of land ownership affected by project including purchase and construction easement.		2	Review statement for deficiencies, monitor preparation.
G	Evidence of financial capacity of applicant to undertake for preliminary work and project.		11	Monitor preparation of statement or explanation showing proposed method of financing.
H	Statement of proposed operation of project works during low, normal and flood flows.	3, 6, 7, 12	6	Prepare necessary statement based on various task outputs.

TABLE 1 - TASK 10 (cont.)

FERC LICENSE APPLICATION: EXHIBITS

Exhibits	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
I	Estimate of dependable capacity and average annual energy output of the proposed project.	3, 6	6	Review for adequacy, monitor preparation.
J	General map showing project boundaries, features and general location.	2, 6, 8	6	Review for adequacy, monitor preparation.
K	Detailed map of project area clearly showing project boundaries, survey data, land ownership and location of project features.	2, 6, 8	6	Review for adequacy, monitor preparation.
L	General design drawings of all principal structures and appurtenant features and other works of the project.	2, 3, 4, 5, 6, 8	6	Review for adequacy, monitor preparation.
M	General descriptions of mechanical, electrical and transmission equipment and appurtenances.	6, 8	6, 8	Review for adequacy, monitor preparation.
N	Detailed estimate of cost of developing the project.	1, 2, 6, 8, 9, 11	9	Review for adequacy, monitor preparation.
O	Detailed engineering and construction schedules.		9	Review for adequacy, monitor preparation.
P & Q	Not required.		None	None
R	Proposed plan for full public utilization of project waters and adjacent lands for recreational purposes.	2, 6, 7, 12, 13	10	Prepare plan in consultation with State, native owners, local communities, others.

TABLE 1 - TASK 10 (cont.)

FERC LICENSE APPLICATION: EXHIBITS

Exhibits	Description	Primary Contributions From Task Numbers	Complete Product Produced Under Task	Required Additional Effort Under Task 10
S	Report on the effect of the project upon the fish and wildlife resources of the project area.	3, 6, 7, 12	6 - Drawings 7 - Text	Review fish passage and mitigation drawings under Task 6 for adequacy. Review report from Task 8.
T	Statement of reasons why development of the project by applicant rather than by the Federal Government would be in the best public interest.	1, 11, 12, 13	10	Prepare statement.
U	Statement showing the manner in which the power and energy produced by the project will be utilized.	1, 8, 11	11	Review statement for adequacy, monitor preparation.
V	Map, text, photographs and drawings to describe the architectural and landscaping treatment proposed for the project works.	2, 6	6	Review for adequacy, monitor preparation.
W	Environmental report.	1, 7, 12	7	Review for adequacy, monitor preparation.

TASK 11: MARKETING & FINANCING

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A.5.12 - TASK 11: MARKETING AND FINANCING

(i) Task Objectives

To establish the feasibility of financing the project and to develop an approach which provides optimum financing cost to Alaska power Authority and the best overall benefit to the State of Alaska. An essential element of this task will be to build confidence in the project.

(ii) Task Output

The principal output of this task will be the draft support documentation for bond offering. While nine primary documents and approximately sixteen additional support documents are involved, some will be prepared with relative ease because the data contained therein will necessarily have been produced for other purposes. Notable outputs unique to the marketing and financing issue include a series of risk analyses and procedures for risk control and minimization, as well as a taxation report addressing the important question of eligibility for tax-exempt bond issuance.

Documents will be produced under three main categories:

(a) - Project Overview, including

- Review of Design and Construction Concepts and Methodology
- Review of Cost Estimates and Schedules
- Economic Limits of Project
- Preliminary Assessment of the Financing Plan and Bond Offering Documentation
- Review of Environmental Constraints
- Development of the Organization and Expertise Sources
- Major Risks and Responses

(b) - Internal Reports for Management/ Financial Consideration (Provisional Listing)

- Financing Requirements of all Parties and the Completion Guarantee
- Assessment of Capital Costs and Schedules
- Assessment of Critical Engineering Tasks and Associated Risk Analysis
- Project Contingencies, Risk Analysis and Planning

(b) - Internal Reports for Management/ Financial Consideration (Provisional Listing) (Cont.)

Environmental Agencies Requirements

Native Peoples Requirements

Probable Economic Limits to Project

Inflation and Escalation Assessment

Overrun Possibilities

Risk Management Organization and Risk Minimization Policy

Security of Project Capital Structure

Economic Impact Preview

Evaluation of Alternative Markets Available for Susitna Output

Evaluation of Alternate Options for Meeting Rail Belt Power Needs

Review of Construction Contract Performance History in Alaska re Cost and Schedule

General Economic Review

(c) - Draft Bond Documentation (Provisional Listing)

A. Primary Volumes

Power Contracts

Engineering Report

Statutory Agreements, Legal Approvals and Land Claims

Summary of Corporate Documents

Technical Abstract and Engineer's Certificate

Construction Cost Estimate Summary

Construction Schedule and Project Expenditure Program

Insurance

Financing Summary

(c) - Draft Bond

B. <u>Support Volumes</u>

Overall Project Organization

Engineering Reports (Construction)

- Access and Site Preservation
- Environmental Standards, Monitoring and Control
- Quality Assurance and Testing Programs
- Support Facilities and Logistics

Engineering Reports (Operations)

- Operating and Replacement Expenditures
- Chargeable Corporate Expenditures

Labor Agreements

Plan for Alaska Manpower and Procurement Content

Risk Management and Minimization

- Risk Analysis and Control
- Risk Minimization

Taxation Report

Legal Report

Review of Giant Projects

- Financing
- Construction and Engineering

Alternative Energy Sources

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(iii) List of Subtasks

Subtask 11.01 - Project Overview Preparation and Updates
Subtask 11.02 - Internal Report Preparation
Subtask 11.03 - Alternative Power Source Risk Analysis
Subtask 11.04 - Susitna Base Plan Initial Risk Analysis
Subtask 11.05 - Susitna Base Plan Extension and Revision
Subtask 11.06 - Susitna Financing Risk Analysis
Subtask 11.07 - Resolution of Tax Exempt Bond Issue
Subtask 11.08 - Identify Parties in Interest
Subtask 11.09 - Revenue Assurance Procedures
Subtask 11.10 - Liaison with APA Bond Underwriting Managers
Subtask 11.11 - Draft Documentation for Bond Offering Support

(iv) Subtask Scope Statements

It is recognized that Susitna is most likely to proceed on the basis of a Project Financing. Essential to this will be an accurate determination of revenues and properly established energy sales agreements. Furthermore, all project risks must be identified, their potential impact assessed, and appropriate contingency plans and provisions made.

In the approach recommended, a close working arrangement will be established from the outset of the study betwen technical, economic and financial advisory groups. The interaction between these interests will be developed through a series of specific tasks which provide the Authority with successively more comprehensive outlines and definition of a financing plan.

As the study proceeds, the specific requirements for supporting material essential for financing will be identified and its preparation undertaken in close collaboration with the selected bond underwriters. The completeness and excellence of bond offering support documentation is judged to be of crucial importance to a successful project. The work involves numerous, complex and interlinked tasks; and only comprehensive pre-planning can achieve the desired result.

In order to present the project in proper perspective to the many parties involved--Federal, State and local agencies, regulatory authorities, power purchasers, potential lenders, institutions, political groups and public--a comprehensive overview will be prepared. This will initially be in general terms, but will endeavor to cover all the interrelated elements of the project. As work proceeds, successive editions of the overview report become more explicit and complete.

It will be recognized that the knowledge and enthusiasm of many who have the power of veto or constraint over the Susitna project will be less than that of Alaska Power Authority and those most closely involved. Studies and explanations which may seem unnecessary to the sponsoring group may well be needed to convince third parties and engender their enthusiasm.

It is furthermore vitally important to disperse the knowledge amongst those employed in the project that all potential problems have been thoroughly examined and solved. This will generate the necessary degree of infectious enthusiasm which is an essential ingredient for even a determined team to succeed.

The work of the interdisciplinary group incorporating technical, economic, financial, and other skills would, furthermore, demonstrate clearly for management consideration the clear economic limits to the Susitna project (e.g., its maximum acceptable cost) and the time period in which its accomplishment must be regarded as a certainty before other measures to meet Alaska's power needs would have to be adopted. While examination of the negative limits of the project could be regarded as an expression of pessimism or even, in the ultimate, capable of cancelling the project, we consider such analysis vital. It should serve to establish the general robustness of the project and to demonstrate beyond doubt to the various governments, investors, lenders, completion guarantors and others the viability of any recommended scheme for development.

As the various elements of the project study reach the appropriate level of completion, it is planned to apply a rigorous analysis of risk and to recommend contingency provisions. The approaches to be used would involve modern techniques of analysis and probability assessment and deal with cost, schedule, technical and other controlling elements of the project.

The approach to be adopted would derive full benefit from previous financing efforts for major capital projects requiring capital funding of $1 billion or more. Experience has demonstrated the need for close and effective interaction between the owner and the various elements of his advisory team.

(v) Logic Diagram

A logic diagram is presented at Plate 1 of Task 11 as the basis for graphically illustrating the manner in which various documents are prepared, interrelated, and assembled.

(vi) Investment Banker Inputs

Associated with us in Task 11 will be the investment banking firm of Salomon Brothers which is described in their memorandum at Section C of this Plan of Study. Salomon Brothers will apply its professional skills, experience, and judgement as a major investment banker to assist us in every aspect of Task 11 at a total level of effort to be determined. **Costs throughout the various subtasks include both Acres and Salomon Brothers work.**

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Subtask 11.01 - Project Overview Preparation and Update

(a) Objective

Provide a key project document which reviews all major aspects of the project and its objectives, determining in principle whether these can be successfully met; provide through successive updating a continuing reassessment of the project's overall viability and financibility as various milestones are reached; and allow multidisciplinary inputs from many sources to be properly coordinated into a cohesive and well-balanced definition of the project.

(b) Approach

This subtask will be performed by a small team who will receive inputs from many multidisciplinary sectors involved in the study. Initially the Project Overview will concentrate on descriptive outline of the project objectives, the site for development and the project facilities. Capital costs and schedules will be at the outset preliminary only, but nonetheless considered adequate to determine initial overall viability. The Project Overview will identify the sensitivity to various risks and outline methods of mitigating these and possibly removing some from further consideration.

The project overview and its subsequent revisions in updated from at intervals of about 6 months throughout the study will be presented from the "owners viewpoint" and consider all important aspects which affect acceptance, financibility and the undertaking of construction of the hydroelectric facilities.

The team will be directed by experienced senior staff familiar with the approach essential to such "Giant Projects" and the complex financing arrangements that these involve.

In achieving its goal of preparation of a comprehensive, clearly understandable, concise and accurate overview of the project, the Project Overview Task Force will call on specific inputs from many sources, including:

- Technical
- Environmental
- Economic
- Marketing
- Financial
- Insurance
- Transportation
- Labor
- Tax
- Legal
- Political

Typical elements of the Project Overview are listed in Subparagraph (ii)(a) of Task Output above.

The final issue of the Project Overview during the study phase will provide a valuable summary document to bridge into subsequent licensing and preliminary design phases of the work. Eventually its content will have significant value for the Bond Offering Support Document and a variety of other applications, including preparation of project brochures as part of the public participation program.

(c) Discussion

The concept of the continuously updated "Project Overview" is of relatively recent origin and has developed from the special needs of large complex projects. It is necessary to address the complexity with a well planned compilation of material which places all the technical, commercial, economic, financial, contractual, environmental and other aspects in proper perspective and demonstrates that all vital problems are being sensibly addressed. The overview is planned to provide a consistent thread of documentation through the whole study process and, if construction should proceed, to provide a datum base for judging actual performance of the many elements in relation to the plans.

As the documents will have to serve many varied and non-technical interests, the language must be appropriately chosen and carefully edited for clarity and ease of understanding. Extensive use will be made of graphics, drawings, maps and pictorial illustrations. Production and binding will reflect the level of economy appropriate to draft and eventually final documentation.

(d) Level of Effort

Task Force $154,000

(e) Schedule

Throughout the study period.

Subtask 11.02 - Internal Report Preparation

(a) Objective

Prepare topical reports, for management consideration, on those aspects of the projects which have a strong bearing on financibility of the project; present material derived from the overall study in form suitable for easy assimilation by non-engineering participants in the overall task; and present the risks to which the project is exposed in the proper perspective.

(b) Approach

The team provided to assess the overall financibility of the project will be responsible for drawing together from many sources data, viewpoints, reports, assessments, impact statements, documents and a variety of other supporting material. In carrying out this task, the multidisciplinary specialists who will be supporting the team will assemble and edit topical internal reports for consideration by managerial staff of the Authority, their financial advisors/underwriting managers and others guiding the project through its study phase to implementation or abandonment. The internal reports may ultimately form a substantial proportion of documents to be subsequently produced in direct support of the financing or for a variety of other purposes. Every effort will be made to foresee all future possible uses of the material and its presentation will be appropriately arranged.

One element of the internal reports which will receive special consideration is risk assessment, which will be applied to several aspects of the project such as technical, financial overrun, schedule delay, operating reliability, etc. Means of mitigating project risks will be dealt with in a comprehensive fashion as will be the contribution from insurance sources in dealing with residual exposures. The important detailed risk analysis itself is covered under subtasks 11.04 through 11.06 below. Related internal reports prepared as a a part of this subtask will present the results of those detailed professional studies in a manner which can be easily understood by decision makers whose ultimate agreement is essential to eventual construction.

Subparagraph (ii)(b) of the Task Output above sets out a provisional listing of typical documents which may be required. The final listing would be planned at an early stage of the study in conjunction with the Authority and their advisors. Control sheets outlining responsibilities for specific input, index of contacts, and required schedule will be prepared in this planning stage.

The internal reports provide, on a selective basis, much of the material for the various editions of the Project Overview and the production of both series will be closely coordinated.

The goal will be to prepare a consistent and cohesive series of reports which will clearly address all the vital issues affecting project release for construction.

(c) Discussion

While it might well be argued that documents of the type envisaged are the inevitable products of a comprehensive study, the benefit of a specific source of consistent internal reports is that the Authority will receive objective, well balanced, professional arguments on key issues to allow properly informed decisions. It is important to note that this approach is responsive to the APA plan to remain a lean, efficient organization. In a bigger and more highly staffed organization undertaking a major project of the scale of Susitna, the internal reports would be produced, no doubt, by individual specialist departments for the owners' project team responsible for final decision.

The proposed approach permits APA to avoid overstaffing for relatively short study or project management periods. An opportunity is offered whereby the special project task force performs these responsibilities under the control and direction of the Executive Director and the Board.

The team would be closely linked to the overall project study organization and perform functions which will be an essential part of the study task. It will serve, however, the owners' control group directly in providing the basis for assessment and decision on many issues having an impact on the project.

(d) Level of Effort

Task Force $183,000

(e) Schedule

Throughout the period of study.

Subtask 11.03 - Alternative Power Source Risk Analysis

(a) Objective

Examine uncertainty with an emphasis on relative differences dependent upon electricity source patterns; identify key uncertainty differences and key interdependencies; and if necessary, quantify uncertainty differences and their interdependencies; establish the validity of key assumptions; and assess viable levels of risk in terms of the State of Alaska's electric power generation mix.

(b) Approach

Acres will coordinate the assessment. Input will be obtained from personnel responsible for each study component, APA source documents and their authors, related reports, and related general literature. Established cross-impact analysis techniques will be recast in the general risk analysis framework developed by Acres to establish potential variation ranges conditional upon the values of other key variables. The key difference is the treatment of time as a continuous process rather than a series of events. To consider these relationships, we will identify the reasons for potential variations, concentrating on broadly defined reasons which have different effects upon each of several source mixes. For example, alternative growth rates developed under Task 1, Power Studies, will be related to two or three different rates of fuel cost escalation. Simple functional relationships will be established to illustrate key interdependencies. A number of power generation patterns with and without Susitna will be evaluated in terms of a sensitivity analysis using these conditional relationships between extremes.

If the case for or against Susitna is not clear, on expected cost grounds, these simple relationships will be refined, associated uncertainty will be quantified, and the validity of key assumptions will be established to the extent possible within budget extensions not considered in this proposal. Expected future electric power cost risk relationships for each electric power generation pattern considered will then be related to the need for the APA to avoid risky situations and mitigate the effects of undesirable situations.

(c) Discussion

General agreement on the extent of such dependencies will not be easily obtained. However, it is a key issue which should not be ignored. Most people will be sympathetic to the existence of some dependence, and minimal dependency assumptions may be all that is necessary to establish a clear case. A simple but realistic initial approach is a low cost minimum risk approach. Extension must be assessed in terms of initial results.

Providing conditional estimates will be a useful aspect of assessing base estimates, and associated costs for other participants are incorporated in their provisions, with the exception of WCC. For related reason, no attempt to cost APA input has been made. Expenses account for the need to seek a wide spectrum of expert opinion.

(d) Level of Effort

Task Force (WCC)................................	$ 2,500
Task Force (Acres)..............................	15,000
Total Subtask 11.03.............................	$17,500

(e) Schedule

Weeks 0 through 30	Development of initial conditional relationships and sensitivity analysis based evaluation of alternatives
After week 30	Extension and refinement if necessary as necessary, overlapping subtask 12.04 if necessary.

Subtask 11.04 - Susitna Base Plan Initial Risk Analysis

(a) Objective

Identify all relevant risks in terms of specific problems associated with specific major components of the project and key aspects of the alternative power source risk assessment developed in subtask 12.03; identify all relevant preventative and responsive measures for these risks; identify which risks are minor given effective responses, and which need further attention; make a preliminary quantitative assessment of some key construction time risks, and their relationships with other key project cost risks, flagging risks which are important but best treated as conditions with respect to the current quantitative analysis; stimulate information flow between planning groups with respect to likely departures from the base plan; and stimulate documentation of problems and solutions to those problems underlying the base plan.

(b) Approach

Acres will coordinate the assessment. Input will be obtained from project personnel responsible for each component. Procedures developed by Acres will be used to assess construction time risk as follows:

Risk lists will be produced, labelling and describing all the relevant risks all those involved can identify.

Response lists will be produced, labelling and describing all relevant responses associated with each risk.

Secondary risk and response lists will be produced, considering risks associated with responses.

Rough quantitative assessment of risk/response sequences will allow some risks to be identified as minor, and not worth further analysis at present.

Still using risk/response lists, responses will be partially structured. Responses common to more than one risk will be identified. Responses will be preference ordered. Where possible, decision rules defining when responses would be used will be identified.

Special diagrams will be constructed to summarize the above analysis in a simple form.

Key base plan assumptions and key assumptions concerning responses to potential problems will be identified.

Probabilities necessary to assess key assumptions will be estimated. Most will be very specific conditional probabilities: for example, what is the probability of x working days for a particular activity in a particular month?

The implications of key assumptions will be examined, first in the context of specific risks for specific activities, gradually at a broader and broader level. For example, we will assess the chance of achieving the planned work on a specific activity in a specific season in relation to one or two key risks first, then look at other risks and other seasons. We will not relate different activities until we are satisfied with assumptions key to the activity itself.

A variety of output forms will be used, depending on the questions being asked of the analysis. Most will be comparative probability distribution representations: for example, the probability of finishing activity y by month x given a start in May, June, July, etc.

Construction time risk will be summarized, and converted to construction cost risk.

Other sources of construction cost risk will be considered in a similar manner, and linked to produce overall construction cost probability representations for confidence limit assessment purposes. Appropriate confidence limit assessment will be based on a comparison of quantified risks and nonquantified risks which must be treated as conditions.

Construction cost risk analysis will take place in a fixed time frame structure, unlike the PERT based analysis usually employed. That is, we will consider uncertainty in terms of "how much work can we achieve in a given time", instead of "how long will it take to achieve a given amount of work". This approach makes it much easier to assess probabilities, always a difficult task. It facilitates the consideration of weather windows and other seasonal dependencies. It also facilitates integrating construction cost risk with inflation and escalation studies at this point.

Other sources of project risk will be considered qualitatively in a similar manner, structuring risks and responses via listing procedures and simple summary diagrams.

Computation procedures are based on numerical integration techniques in a semi-Markov process framework. Another key advantage of the fixed time frame is the efficiency and precision of this approach relative to the more usual simulation or moment integration analytical procedures.

All aspects of the Acres' approach to risk analysis have been widely used in the context of fault tree and event tree analysis, reliability analysis, generalized PERT, Markov process and decision tree analysis. However, the way we have integrated these aspects into a procedure tested in a variety of application areas is unique. Areas of application of the integrated procedure include hydro projects, thermal power projects, arctic gas pipelines, offshore North Sea oil pipelines and platforms, underground energy storage projects.

(c) Discussion

The effort expended on risk analysis can be tailored to an available budget. However, it must be expended in a systematic manner, and experience suggests that at this stage in a project's life a relatively simple quantitative analysis will suffice provided risks and associated preventative and responsive measures are carefully identified. If they are not, quantification of risks is rather meaningless, because it is not clear what has and has not been included.

(d) Level of Effort

Task Force (FMA)	$ 5,500
Task Force (Acres)	19,000
Total Subtask 11.04	$24,500

(e) Schedule

Weeks 53 through 75	Develop initial risk analysis as base plan is developed, including quantitative analysis to test key base plan assumptions.
After week 75	Prepare risk analysis documentation for license application submission.

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Subtask 11.05 - Susitna Base Plan Extension and Revision

(a) Objectives

Periodically revise the base plan initial risk assessment as the base plan develops; explore key risk areas identified earlier; assist with base plan development as and when necessary; and respond to FERC requests for further analysis.

(b) Approach

Within the basic framework established in Subtask 12.04, further specific extensions and revisions.

(c) Discussion

Experience suggests risk analysis can be extremely useful at this stage in a project's development, but it is difficult to predict what sort of issues will benefit from further analysis until preliminary risk analysis results are available.

Costing is necessarily vague at this stage, but we believe the figure quoted should allow updating as necessary and response to a reasonable number of risk areas uncovered earlier and assessment of key changes proposed for the base plan.

(d) Level of Effort

Task Force (Acres)....................$20,000

(e) Schedule

As and when necessary.

Subtask 11.06 - Susitna Financing Risk Analysis

(a) Objective

Build on earlier risk analysis consideration of financial issues not yet developed, including assessment of contract and insurance arrangements, and an appropriate level of direct and indirect "insurance".

(b) Approach

Within the basic framework established in Subtask 11.05, specific extensions and revisions, in terms of both quantitative and qualitative analysis.

(c) Discussion

Earlier listing and structuring of risks and responses is of great value at this stage. Each proposed contract can be assessed against appropriate checklists of potential problems, and contract arrangements or insurances which cover a number of different sources of risk can be developed into an effective overall risk management pattern.

This subtask will be performed in its entirety subsequent to submittal of license application. Thus, the required level of effort, although presented below, is not included in the estimated costs associated with submittal of license application.

(d) Level of Effort

Task Force (Acres)....................$10,000

(e) Schedule

From license application to bonding.

Subtask 11.07 - Resolution of Tax Exempt Bond Issue

(a) Objective

Explore all legal means to secure tax-exempt financing for the Susitna Project and identify and describe those measures which must be taken in each case to secure that end.

Rank order preferred approaches in the event more than one legal means is identified. Prepare a report summarizing reasons tax exempt financing is found to be impossible in the event no legal means is identified.

(b) Approach

A memorandum on financing considerations prepared by Salomon Brothers is included in Section C to this Plan of Study. As noted therein, a number of possible alternatives under the IRS Code can be explored. The special rules provided under Section 103 of Treasury Regulations for applying trade or business test and security interest test to bonds issued to finance an electric generating facility owned and operated by an exempt person (in this case, the State of Alaska or a public power authority) will be considered in a series of sequential steps summarized as follows:

(1) Classify the anticipated purchasers of power from the Susitna project into exempt and nonexempt persons. For example, municipalities such as Anchorage and Fairbanks will be exempt persons, whereas private electrical co-ops will be nonexempt.

(2) Determine whether any one nonexempt person will contract to take, or take or pay for, more than 25 percent of the project output of the Susitna project. If there is such a person, then the trade or business test is met.

(3) If there is no such person, identify the nonexempt persons who will each pay annual guaranteed minimum payments exceeding 3 percent of the average debt service on the Susitna bonds. The trade or business test is satisfied if the aggregate amount of power which these persons contract to take, or take or pay for, exceeds 25 percent of the project output of the Susitna project.

(4) If the trade or business test is met, total the payments that will be both pledged or used to pay debt service on the Susitna bonds and made pursuant to the contracts referred to in either paragraph 2 or 3 above. The security interest test is met if this aggregate amount exceeds 25 percent of the total debt service on the Susitna bonds.

If it appears that the Susitna bonds may be industrial development bonds because of the commitments by nonexempt persons to purchase power, consideration may be given to altering the makeup of the group of purchasers to avoid the trade or business test or security interest test. Further details are provided in the

Salomon Brothers memorandum. Assuming that one or more approaches are found to be possible, each will be evaluated in terms of the associated difficulties and probabilities of successful defense against challenge by or on behalf of regulatory authorities. All reasonable approaches will be rank ordered and the apparent best will be developed into a series of explicit measures to be taken by the State (including recommendations for legislation to be passed), the Alaska Power Authority, and others.

In the event that tax exempt financing is found to be impossible, a report will be prepared detailing the reasons that no reasonable approach could be found.

(c) Discussion

The question of tax-exemption on interest to be paid on bonds issued to finance the project is of extreme importance, for the overall cost of the project power and the type of financing plan to be developed hinge upon its resolution. So important, in fact, is this issue that even a negative report should not necessarily be regarded as a final and irrevocable ruling on the matter. Indeed, given the importance which the federal government has now attached to domestic energy production (especially from renewable resources) it is not inconceivable that federal regulatory or statutory changes can be achieved.

In the event, however, that negative findings on the tax exempt question are produced and cannot be reversed, the financibility of the project will not then necessarily become doubtful. The best alternative to tax exempt bonds will be recommended by an experience professional investment banking firm whose successful historical participation in large project financing is well documented.

(d) Level of Effort

Task Force $150,000

Total Subtask 11.07............................ $150,000

(e) Schedule

Weeks 1 through 20. Intermittent updates thereafter.

Subtask 11.08 - Identify Parties in Interest

(a) Objective

Identify potential candidates to share some of the direct and indirect project risks and describe their possible involvements.

(b) Approach

A survey of all organizations and entities with any possible direct or indirect risk sharing involvement will be accomplished. These parties might include, for example, municipal electric systems, rural electric cooperatives, investor owned utilities, the Alaska Power Administration, and others. A profile will be drawn up for each and an assessment will be made as to how much of the total risk each may be expected to share under appropriate alternative scenarios and as to how such sharing can reasonably be accomplished.

(c) Discussion

There are a number of basic project financing risks which must be addressed. The analysis, assessment, and, where appropriate, quantification of these risks will be accomplished under Subtasks 11.04 through 11.06. Financing risks include:

-- Cost overruns prior to completion
-- Late completion and non-completion
-- Partial or total post-completion outages
-- Customer failure to provide anticipated cash flows
-- Regulatory risks, particularly insofar as new regulations affect the operation (and, therefore, of course, the profitability and/or consumer costs).
-- Technological risks, particularly insofar as the extent to which new or relatively unproven technology may increase financing difficulties.

Given these risks and reasonably detailed profiles of potential risk sharing parties, it is possible to consider a number of alternative participation scenarios. As successive iterations of the risk analysis efforts occur, the possible involvements of parties-in-interest are correspondingly clarified. An essential first step in this process, however, is the task of identifying and profiling potential candidates. Thus, this subtask provides an explicit recognition of that need.

(d) Level of Effort

Task Force (Acres).......................... $25,000

Total Subtask 11.08.......................... $25,000

(e) Schedule

Weeks 10 through 30

Subtask 11.09 - Revenue Assurance Procedures

(a) Objective

Explore alternative means to provide adequate revenue assurance to protect investors against the risk of default; develop a strategy for success.

(b) Approach

For large energy projects, the necessary revenue assurance may be derived from a demonstration of demand for the project output and adequate customer and regulatory support of the price for the power. Demonstration of demand can be satisfied by power sales contracts between APA and the immediate customers (e.g., municipalities, cooperatives, military bases, industrial plants, etc.). We intend to consider a number of alternative types of commitments and match them against immediate customers identified earlier in the group of parties-in-interest (see Subtask 11.08). Certain specific commitment types are described in the Salomon memorandum in the Appendix. These include take-or-pay obligations, take-and-pay obligations, minimum payment obligations, and step-up provisions.

Since price regulation and other regulatory constraints would necessarily affect the project, it is important to include discussions with all governmental and regulatory agencies in this exploration of revenue assurance.

In addition to power sales contracts, guaranties by the State or Federal government or others would provide further assurances. Guarantee possibilities will be identified and a preliminary assessment will be made of the probability of acquiring them.

A number of funds will be required (including, for example, "Reserve and Contingency Fund" or Operating Fund") to ensure protection against unexpected shortfalls. Each such requirement will be identified along with its source.

As a final step in the development of revenue assure procedures, the apparent best strategy for successfully achieving the desired degree of revenue assurance will be described in a report to be prepared as a part of this subtask.

(c) Discussion

The basic credit risk against which investors attempt to protect themselves is the risk of default. The risk of default lies in the borrower's inability to meet interest and principal payments on his debt obligations in a timely fashion. Adequate revenue assurance protects the investor against this risk.

It will not be enough to conduct a one-time study of the revenue assurance issue and then assume the results will continue to remain valid throughout the course of the financing effort. Rather, a relatively continuous updating process is essential. In this regard, the provision of investment banker's services by a firm experienced in providing financial services for large projects is particularly important.

(d) Level of Effort

Task Force (Acres).......................$75,000

(e) Schedule

Weeks 100 through 120. Subsequent schedule to be determined.

Subtask 11.10 - Liaison with APA Bond Underwriting Managers

(a) Objective

Provide a continuing input as appropriate from study tasks of information and data which may have an impact on financing; provide engineering advice to the financing management group; and report to the Project Manager on any issues where financing considerations have an impact on the evolution of the project.

(b) Approach

Financing of a major project such as Susitna will call for a level of effort and ingenuity well beyond that normally involved in public works undertakings. Experience (particularly from the $1 billion Churchill Falls Project) has established the benefit in a particularly close relationship between technically oriented senior staff closely associated with the engineering related development of the project and the financial, legal, insurance, economic and other professional advisors assembled by the owner. The leader of the task force carrying the responsibilities under Subtasks 11.01 and 11.02 will be eminently suited and placed to provide this liaison function as an essential part of his other duties.

(c) Discussion

In major projects, there must be continual emphasis on multidisciplinary approaches to most of the important issues that have to be resolved. When capital investment is more modest and where many precedent cases are available for guiding decisions, the degree of liaison and interlinking of interests contemplated here might be viewed as extravagant. However, it may be suggested that the exigencies of even less ambitious capital works exposed to excessive cost escalation and the many risks imposed by current public and political attitudes call for closeknit coordination of all project interests throughout the undertaking from concept to completion.

The target is completion in the most efficient and cost-effective way possible and the strictest level of adherence to schedule and budget throughout the project. The aim can be most effectively taken by close cooperation between all interests from the outset.

(d) Level of Effort

(Costs of these services integrated with all other subtasks in Task 11.)

(e) Schedule

Continuous through the full period of study.

Subtask 11.11 - Draft Documentation for Bond Offering Support

(a) Objective

Review with the Authority's Bond Underwriting Manager the requirements for support documents; prepare and issue outline index and content specifications and allocated responsibility for input; prepare, edit and produce successive draft documents in parallel with other findings, reports, etc, being produced in the later phases of the overall study, and prepare "Engineers Opinions" to support certification of the project.

(b) Approach

Throughout the financing support task, attention will be continually focused on the ultimate objective of a successful bond issue. Very large projects requiring financing at levels of $1 billion or more call for a particularly high standard of support documentation to build a sufficient level of confidence in the investment potential. Managers of major financing institutions are becoming increasingly sophisticated in their approach, particularly to major projects and owners and underwriting managers must respond to their more exacting requirements.

We see the vital importance of preparing inputs to the bond offering support documents as the study proceeds. It would be planned that draft documents would be available by the conclusion of the study and to be available for further refinement as the project proceeds through licensing to its release date.

The specific approach to be adopted would parallel the successful precedent of Churchill Falls Hydroelectric Power Development which led in 1968 to the marketing of $550 million in First Mortgage Bonds. While in this case work was heavily concentrated in a 3-month period in 1967 and continued at a lesser level for 15 months in 1968, it is recommended that for Susitna the support materials should be methodically assembled through out the study period and prepared in draft form well in anticipation of any offering. A provisional listing of Bond Offering Documentation is set out in subparagraph (ii) of Task 11 above, and a summary of the objectives of each of the proposed documents is repeated at Table 1 of Task 11.

(c) Discussion

It will be apparent from the provisional listing of Documents that a wide range of interrelated topics must be addressed. This calls for input from a multidisiplinary group of specialists and sensitive coordination of all material into a cohesive, balanced and interrelated series of documents. These serve to demonstrate that all important questions have, in fact, been properly addressed and that the project has a high level of overall security as a result.

In view of the legal significance of these documents, the process of editing, approval and publication will require close working arrangement with the Authority's counsel, the underwriting managers, legislative interests in the State of Alaska, and the owners' management team. The effort requires a painstaking level of careful processing of very large amounts of data and material and justifies its assignment to our experienced team with appropriate prior exposure to this function.

A perusal of the list of bond offering support documentation as displayed in Table 1 reveals that there are great similarities to documentation required as exhibits to the FERC license application (see Task 10). Thus, we will, in many cases, use the same documentation both as an exhibit and as bond offering support documentation. In others, it will be necessary to reformat exhibit data to meet financing needs. To the extent possible, however, bond offering support documentation will be delayed until after license exhibits have otherwise been prepared.

Annex A to Task 11 refers to work carried out for BRINCO on Churchill Falls Hydroelectric Power Development in 1967-68.

(d) Level of Effort

Task Force (Acres)..........................$136,000

(e) Schedule

Commence month 6 and to be presented in a form for continuing effort into subsequent phases of the project.

TABLE 1 OF TASK 11

ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC POWER PROJECT

PROVISIONAL LIST OF BOND OFFERING SUPPORT DOCUMENTS

A - PRIMARY DOCUMENTS	OBJECTIVE
1. Power Contracts	To outline the terms and conditions of sale of the power and energy output from the Susitna project.
2. Engineering Report	To provide a comprehensive statement, in simple language, regarding the physical nature of the site, the basis of development, the determination of energy output, and a description of all facilities.
3. Statutory Agreements, Legal Approvals/Land Claims	To provide a comprehensive assembly of all relevant agreements as far as possible in their original layout and form.
4. Summary of Corporate Documents	To provide a comprehensive assembly of documents relating to the Alaska Power Authority and any other participants in the project.
5. Technical Abstract and Engineer's Certificate	To summarize the engineering report, construction cost estimates, schedule, operating and replacement expenditure estimates, and other documents leading to firm conclusions supported by an Engineer's Certificate of Opinion relating to operation, cost and schedule.
6. Construction Cost Estimate	To set out the basis of the construction cost estimate, including contingency provisions and to provide the necessary detail to establish an adequate level of completeness and confidence.

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7. Construction Schedule and Project Expenditure Program	To provide a concise, but detailed, description of the construction schedule and project expenditure program of all facilities and critical path networks of all supporting activities in the overall construction plan.
8. Insurance	To set out a concise statement of risks during construction and operation with an evaluation of the maximum foreseeable loss.
9. Financing Summary	To provide a summary of equity, debt and completion guarantee standby financing requirements with a schedule of drawdowns to meet construction plans.
B - SUPPORT DOCUMENTS	OBJECTIVE
1. Overall Project Organization	To provide a summary of relationships of all companies involved in the project with details of origins, responsibilities and corporate structures, supplemented with organization charts showing lines of reporting and authority.
2. Engineering Reports (Construction)	
2.1 - Access and Site Preservation	To provide a detailed description of the arrangements made for access and heavy transportation to the project site with a full statement of measures taken for site preservation and avoidance of delay arising from environmental concern.
2.2 - Environmental Standards, Monitoring and Control	To provide a comprehensive summary of all applicable requirements, responses and reports concerning environmental aspects of the project construction and operation.
2.3 - Quality Assurance and Testing Programs	To set out quality assurance directives established by the Authority and detailed evidence to demonstrate the methods by which these will be achieved.

2.4 - Support Facilities and	To provide a comprehensive description of all construction and operational support facilities with demonstration of the adequacy of these to meet project requirements, including contingencies.
3. Engineering Report (Operations)	
3.1 - Operating and Replacement Expenditures	To provide details of the basis of estimate for the manning and operating of the power project, and for the continuing maintenance plans.
3.2 - Chargeable Corporate Expenditures	To set out the estimates of corporate expenditures incurred by the authority which can be legitimately charged to operations.
4. Labor Agreements	To review the labor situation on both the national and state level, together with the legislative framework under which special labor agreements may be formed. To provide precedent data on experience with master project labor agreements. To include a statement of intent for such agreements to apply to the project, and to demonstrate the impact of these on project risk exposure.
5. Plan for Alaskan Manpower and Procurement Content	To present sufficient evidence to demonstrate that the desired portion of Alaskan content will be incorporated in the overall project.
6. Risk Management	
6.1 - Risk Analysis and Control	This section will describe in detail the optimal responses to a risk minimization study, the organization of a formal risk management team, its policies and methods of operation. It will also describe review policies and reporting systems designed to ensure continuous updating of both risk identification and response.

6.2 - Risk Minimization	To identify all risks to which the project may be subject and plan responses to them which demonstrably reduce those risks collectively and individually to a minimum. The residual risk figure thus determined is an important factor in demonstrating the reliability and confidence level of the project.
7. <u>Taxation Report</u>	To deal with the impact of all aspects of federal, state and local taxation pertinent to the project.
8. <u>Legal Report</u>	To deal with all aspects of legislation and legal requirements under which the project will be constructed.
9. <u>Review of Giant Projects</u>	
9.1 - Financing	To identify and describe other relevant project financing to demonstrate the adequacy and logic of the project approach.
9.2 - Construction and Engineering	To summarize the experience accumulated from major North American capital projects in relation to achievement of engineering cost estimates and schedules.
10. <u>Alternative Energy Sources</u>	To provide a comprehensive review of alternative energy generation modes applicable to Alaska, with estimates of delivered energy cost and long-term reliability of supply.

ANNEX A TO TASK 11

CHURCHILL FALLS (LABRADOR) CORPORATION LIMITED

Excerpt from "Brinco, The Story of Churchill Falls"
authored by Philip Smith, Chapter nineteen:

On his return to New York, Mulholland (of Morgan Stanley) recommended to his partners that while Morgan Stanley should continue to give advice wherever it could, it should not attempt to set up the Company's project for it. However, he warned them that "we must not undertake the financing of the project and fail", adding: "The statement is often made that this project is going to go ahead regardless, that there is too much momentum, governmental and otherwise, for it to be stopped now. There is probably a good deal of truth in this, but it doesn't necessarily follow that the interests of the company will be automatically protected in the process. In other words, this inevitability which is said to exist does not justify recklessness or carelessness."

Two steps taken as a result of Mulholland's criticism eventually provided him with a formidable arsenal of these arguments. First, a control committee was formed consisting of McParland, Lambert and Mulholland himself------
Second, McParland established a task force which during the summer of 1967 was to carry out probably the most exhaustive analysis ever made of a major construction project and produce a monumental report known thereafter as the "five foot shelf" - sixteen closely packed volumes covering every conceivable aspect of the development. Gavin Warnock, a vice president of Acres and Ken Wolfe, Bechtel's chief estimator, were asked to head this task force and at the beginning of May, McParland gave them a sheaf of foolscap sheets defining in detail the "input" he wanted each volume to study.

Expo '67 created accommodation problems for anyone visiting Montreal that summer but Warnock and Wolfe took over an unoccupied set of offices at 1980 Sherbrooke Street, rented desks, hired temporary secretaries and crowded the various specialists whose talents were drawn on during the next three months into company apartments. More than fifty experts from all over North America eventually contributed to the report - engineers, estimators, schedulers, economists, nuclear power consultants - and then studies encompassed regional economies surveys assessment of the projects' likely effect on eastern Canada and the United States, and on Labrador and Newfoundland, analyses of the competing forms of energy that might appear in the future and detailed financial projections designed to show that the element of risk in the project had been reduced to its absolute minimum.

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ANNEX A (cont'd)

CHURCHILL FALLS POWER PROJECT
BOND OFFERING MEMORANDUM DOCUMENTS

Published October 1968

VOL. 1 POWER CONTRACT

VOL. 2 TECHNICAL ABSTRACT AND ENGINEERS' EVALUATION

VOL. 3 ENGINEERING REPORT

VOL. 4 CONSTRUCTION COST ESTIMATE

VOL. 5 CONSTRUCTION SCHEDULE
PROJECT EXPENDITURE PROGRAM
AND ESCALATION STUDY

VOL. 6 MASTER LABOUR AGREEMENT

VOL. 7 NEWFOUNDLAND STATUTORY AGREEMENTS

VOL. 8 INSURANCE

VOL. 9 OUTLINE OF PROPOSED CONTRACT PACKAGES

VOL. 10 OUTLINE OF CONTRACTING PRACTICES

VOL. 11 MANAGEMENT CONTROL AND INFORMATION SYSTEM

VOL. 12 CORPORATE DOCUMENTS

VOL. 13 OPERATING AND REPLACEMENT EXPENDITURES
GENERATING PLANT AND SUPPORTING FACILITIES

VOL. 14 PLANT AND CORPORATE EXPENDITURES

VOL. 17 REVIEW OF MAJOR CONSTRUCTION PROJECTS

VOL. 18 EVALUATION OF CERTAIN PROJECT CONTINGENCIES

Not Published

VOL. 15 ECONOMIC OVERVIEW

VOL. 16 ALTERNATIVE ENERGY SOURCES FROM
NUCLEAR POWER GENERATION

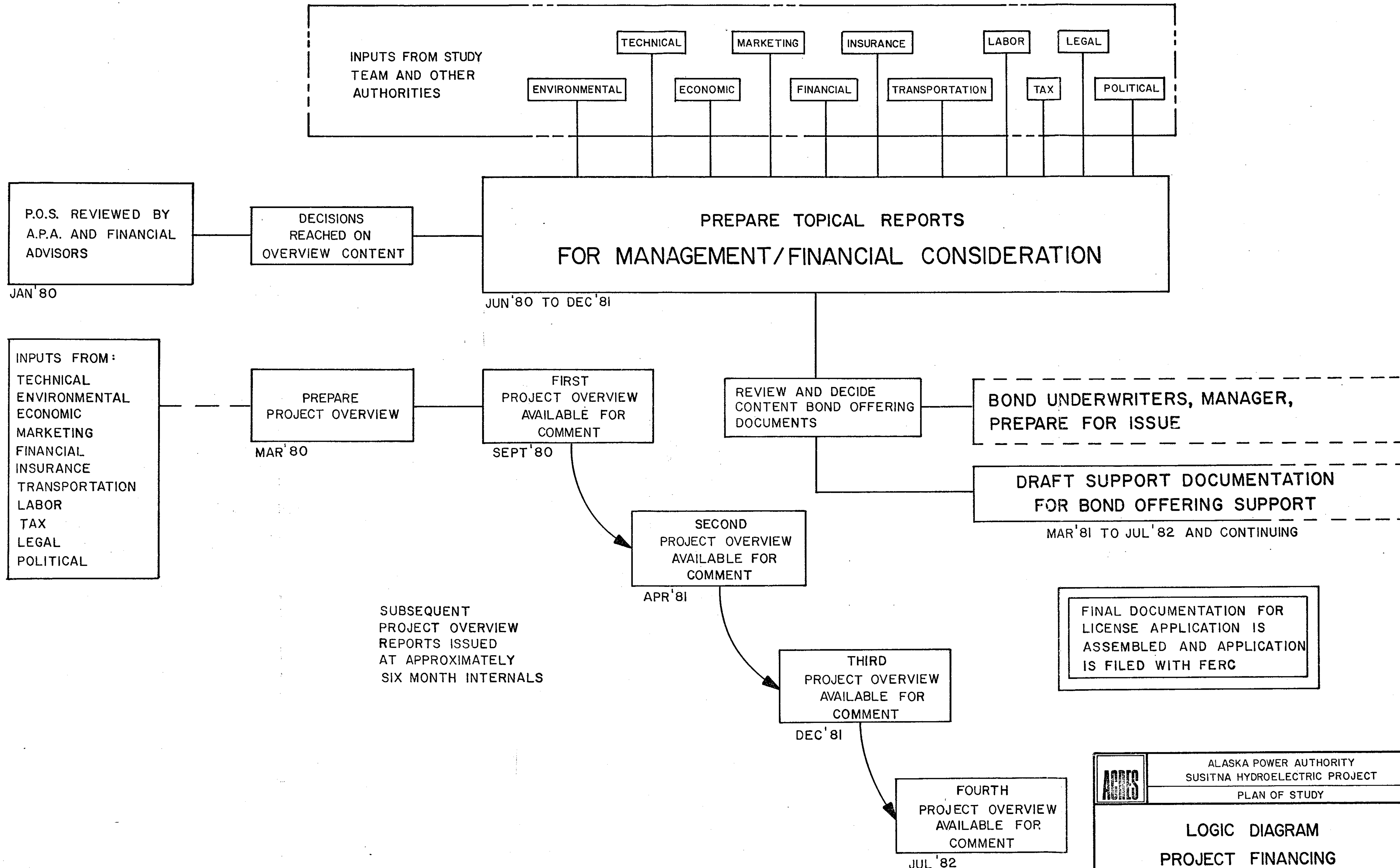
Published August 1970

VOL. 19 PROJECT STATUS REPORT JULY 1970.

ANNEX A (Cont'd)

This extract in Appendix A described in chronicle form the management response to potential financing problems on the Churchill Falls Power Project. It led to the intense activity of the professional task force mobilized by Acres Canadian Bechtel of Churchill Falls, the joint venture put together to provide Engineering and Management of Construction for The Owners. The task force was established to carry forward the assistance to management required by McParland to secure the high degree of confidence required for the overall project financing plan.

The review and comprehensive study referred to in the extract was brought together in some 16 volumes of Bond Offering Support Documents.



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

LOGIC DIAGRAM
PROJECT FINANCING

ACRES AMERICAN INCORPORATED

PROJECT: P 5477.00

PLATE TII.1

TASK 12: PUBLIC PARTICIPATION

A.5.13 - TASK 12: PUBLIC PARTICIPATION PROGRAM

(i) Task Objectives

To keep the public fully informed of plans, progress, and findings associated with conduct of the detailed feasibility study, and to provide a means whereby the public (including individuals, public and private organizations, and various government agencies) can influence the course of the work.

(ii) Task Output

Outputs of the public participation program will include:

-- Transcripts of public meetings, together with subsequent written comments and proposed action lists derived from public inputs

-- Monthly progress reports published and distributed widely

-- Film clips and recordings for release to the news media and for subsequent historical record

-- Minutes of workshop meetings (to be made available upon request at the cost of reproduction and mailing)

-- Minutes of deliberations of external environmental and engineering boards (to be made available upon request at the cost of reproduction and mailing)

-- Progress report brochure to be published and distributed in advance of the January 1981 public meeting

-- Written responses to individual letters of inquiry addressed to the project information office

(iii) List of Subtasks

12.01 Operate Information Office
12.02 Conduct Public Meetings
12.03 Conduct Workshops
12.04 Prepare, Publish, and Distribute Information Materials
12.05 Prepare and Maintain Action List

(iv) Subtask Scope Statements

The logic diagram at Plate T12.1 provides a broad overview of the manner in which the public participation program will be conducted. In general, this program has been constructed to provide a series of iterations which are structured for feedback. Plate T12.2 illustrates the process. On a continuous basis throughout the course of the work, information regarding progress, preliminary findings, and plan revisions will be published; comments will be sought; action lists incorporating issues and concerns will be prepared; the plan of study will be updated; and a new information publication will be triggered--thus completing the loop.

External engineering and environmental boards will provide an independent review as well as a recourse in the event that the consultant's proposed actions or actual efforts are perceived as unresponsive to expressed concerns. Detailed descriptions of individual subtasks are contained in succeeding paragraphs.

Subtask 12.01 - Operate Information Office

(a) Objective

Provide a central point for public access to project information; provide a coordinating agency for processing information requests, comments, and objections; and provide positive control for meeting scheduled information milestones.

(b) Approach

As soon as work commences on the feasibility study, an information office will be opened and a public information project officer will be designated. The effort will demand the full time services of the information officer throughout the period during which the study is conducted as well as require administrative support and the part time assistance of others as the work progresses. By providing this vital link between the public and the study team, we expect to ensure that all inquiries are answered, that no comments are ignored, and that an aggressive information program is carried out.

It will be the duty of the information officer as well to make administrative arrangements for other information activities (e.g., acquiring suitable meeting places for public meetings, arranging for verbatim transcripts, processing written comments, etc.).

(c) Discussion

Experience has shown that the typical professional engineer is reluctant to subject his preliminary findings to public scrutiny (and possibly criticism) until he has gathered all of the data he believes is necessary and has checked and double checked his results. The existence of an information office and the designation of an information officer will provide a means for the public to be kept abreast of what is transpiring as well as what is planned. Daily contact with various project personnel will allow the information officer to discharge his duties properly as well as free the engineers and the environmental scientists to concentrate their attention on the skills at which they are most adept.

It is highly probable that periods of frenetic activity will occur as the information program is carried out. On such occasions, we anticipate seeking the assistance of additional locally hired staff to augment the normal information staff.

Coordination on a regular basis with agencies charged by statute or by executive order with direct involvement, or with organizations such as bulk recipients and distributors of electric power, will generally be accomplished directly at the appropriate action level without intervention or involvement of the information office. Even so, the information officer will be expected to assume the role of expediter in any case where it comes to his attention that required coordination is not being accomplished.

(d) Level of Effort

Task Force (Acres).........................$333,300

Total Subtask 12.01........................$333,300

(e) Schedule

Entire study period.

Subtask 12.02 - Conduct Public Meetings

(a) Objective

Provide widely publicized opportunities, scheduled in advance in convenient locations, for presenting information to the public, soliciting their comments and concerns, addressing their questions, and involving them in the work; establish an official record of these public participation milestones as the basis for subsequent identification of specific actions to be incorporated into follow-on work; and offer the benefit of public reactions to the views of independent external environmental and engineering boards who will have reviewed the recommendations of the project managers at crucial milestones.

(b) Approach

Public meetings will be scheduled for three important decision points:

(1) Near the start of the work so that the public may be informed of the plan of study and afforded an opportunity to comment on it.

(2) After one year's work has been completed, at which time sufficient data will be available to permit recommendations as to whether to proceed. At this point, the public will have available for consideration a river basin plan, a comprehensive alternatives study, a progress report on all study work completed to date, and an updated plan for work to be undertaken in succeeding years.

(3) After preliminary findings have been developed and initial drafts of all exhibits to be submitted with license application to the Federal Energy Regulatory Commission have been prepared.

At each of the above milestones, three separate public meetings will be held in a two week period--one each at Anchorage, Fairbanks, and Talkeetna. Information to be addressed at each of the meetings will be made available at conveniently accessible points (e.g., public and school libraries) or at cost to those who wish to acquire personal copies. In each case, brochures summarizing progress, future plans, and problem areas will be prepared and distributed free of charge.

A comment period of 15 days will be established so that written comments received during that interval can be incorporated in verbatim transcripts. (Note that the 15 day period does not in any way limit public comment throughout the course of the work. Indeed, the information office will receive and acknowledge written and oral inputs throughout the entire study period, and will coordinate the preparation of entries on action lists.) The value of the relatively brief period for response to the public meeting lies in making transcripts available as early as possible and distributing them for consideration prior to the next workshop (scheduled within a few months of each public meeting).

(c) Discussion

The value and complexity of the proposed project as well as its location necessarily demand thorough--and almost inevitably, voluminous--reports, calculations, data tabulations, and the like. While such information will be made available for public scrutiny each time a reasonably separable package has been prepared, it is unlikely that the average concerned citizen will have the time or the education and experience to read and digest all of it. The public meeting affords an opportunity for every citizen to learn of what is planned and what has transpired, as well as to offer comment, advice, and/or criticism in a public forum. To be sure, public meetings are generally too large (and too diverse in interests represented) to make them efficient vehicles for hammering out compromises and courses of action which best meet study objectives while simultaneously addressing key issues raised by conflicting interests. We anticipate satisfying the latter need in part by scheduling and conducting workshops.

The meeting will be conducted in each case by a key member of the Acres organization (usually the project manager or the study director). A panel including a representative of each of the companies forming a part of the Acres team as well as one or more employees of the Alaska Power Authority will be available so that certain questions and concerns can be addressed at the meeting itself.

Public meetings are designed to be just what their name implies--an opportunity for the public to become aware of and involved in the work. In a sense, they are primarily geared toward the needs of individuals, though no attempt will be made to stifle the inputs of organizations or agencies. While public inputs during the meeting and subsequent written comment periods are likely to include significant numbers of expressions of concurrence or of opposition, the results will not be regarded as a vote. Even so, summary records of the range of reactions will be maintained as a part of the record for later consideration during FERC hearings and interventions (if the latter occurs).

(d) Level of Effort

Task Force (Acres)............................	$57,800
Preparation and Participation (R&M)............	7,000
Preparation and Participation (FMA)............	7,000
Preparation and Participation (TES)............	7,000
Preparation and Participation (WCC)............	7,000
Preparation and Participation (CIRI)...........	7,000
Liaison and Review (Acres)....................	2,000
Total Subtask 12.02...........................	$94,800

(e) Schedule

Weeks 4 to 6; 52 to 54; 120 to 122

Subtask 12.03 - Conduct Workshops

(a) Objectives

Provide scheduled opportunities for discussion, coordination, achieving appropriate and acceptable compromises, and in general addressing the needs of organizations and agencies having particularly strong interests in the course of the work; provide the vehicle for inputs and advice from particularly knowledgeable representatives of special interest groups, as well as an opportunity for dialogue not so readily available at public meetings; and provide the public a chance to observe the face to face encounters and the discussions occurring at workshop sessions.

(b) Approach

A total of eight workshops are planned, six of which are scheduled in advance and two of which are reserved to address issues of opportunity. Each such session may last three days or more and may be divided into a series of subsessions so that time can be set aside for addressing the special interests of certain groups.

While it is clear that special workshop interests necessarily include those of the utilities in the Southcentral Railbelt, state and federal agencies charged with regulation and preservation associated with the project, native villages whose lands or livelihood will be impacted, and certain environmental organizations, it is also true that the productivity and advantages of workshop sessions deteriorate rapidly as the number of participants increases beyond a dozen or so. We propose to recommend a manageable number of organizations to APA based upon an attempt to identify interests most clearly and substantively impacted by the project. (In this regard, for example, we would choose a recognized environmental organization operating in Alaska and concerned specifically about project impacts as they directly affect the Alaskan environment and the Alaskan quality of life over a national environmental organization whose objectives may be oriented toward "national" interests and whose representatives have not lived in and may seldom visit the State).

Observation is possible. Even so, oral comments and suggestions from individual observers in attendance will not be solicited during any session. Forms will be available, however, for attendees to express their views.

Subsequent to each workshop, minutes of the meetings will be prepared and published, and action lists will be updated to account for agreements reached during the session as well as to reflect important inputs from various observers.

(c) Discussion

Whereas public meetings (Subtask 12.02) were described as responsive to the participation needs of individuals, the workshop sessions are designed to satisfy group or agency participation needs. The difficulty comes, of course, in selection of proper participating groups. We will make recommendations in this regard, but the choice is properly one for the State of Alaska. Thus we will rely on APA as the arbiter in the event that any interested organization seeks recourse from proposed exclusion.

There is some slight danger that exposing workshop sessions to public view may inhibit participants and keep them from "letting their hair down." In balance, though, we regard the public's right to know as the more important consideration and our costs are derived on the assumption that reasonably large facilities will be required and that a substantial number of interested persons will observe and will express views on the forms to be provided.

By regularly scheduling most of the workshops, we hope to ensure that surprises are avoided and that both the team and sub-session participants are kept fully aware of each other's progress. Given the sheer magnitude of the work, though, it is entirely possible that unforeseen events of great consequence for the proposed project will occur. Two workshops are included in the estimated costs to account for our perception that certain important new issues will need to be addressed when they arise rather than at a future scheduled meeting.

(d) Level of Effort

Task Force (Acres)	$41,800
Preparation and Participation (R&M)	11,500
Preparation and Participation (FMA)	5,800
Preparation and Participation (TES)	11,500
Preparation and Participation (WCC)	11,500
Preparation and Participation (CIRI)	5,800
Liaison and Review (Acres)	4,300
Total Subtask 12.03	$92,200

(e) Schedule

Weeks 18, 32, 47, 58, 72, 89, 106.

Two additional weeks to be scheduled during the course of the study.

Subtask 12.04 - Prepare, Publish, and Distribute Information Materials

(a) Objective

Ensure project information is made available on a regular and convenient basis; make explicit provisions for commitment of resources in support of a strong and aggressive public participation program; and support the assemblage of a proper historical record of the sequence of events leading to license application, and, if results so indicate, to eventual design, construction, and operation of a hydroelectric plant(s).

(b) Approach

This subtask will be undertaken through use of innovative multi-media coverage under the direction of an information officer whose duties will include management of a strong information program. Specific efforts include, but are not limited to, preparation, publication, and appropriate distribution of the following:

(1) Final approved plan of study.
(2) Periodic film clips of "as is" conditions in Susitna basin, alternative sites and/or examples for electric power generation, public meetings and workshops in progress, field investigations, and the like.
(3) Transcripts of all public meetings.
(4) Minutes of workshop meetings.
(5) Monthly progress reports.
(6) Information brochures and pamphlets.
(7) Basin development plan.
(8) Alternatives plan.
(9) Action lists, together with notes as to status of pending actions.
(10) Draft preliminary findings.
(11) Audio and video recordings.
(12) News releases.
(13) Minutes of external board deliberations.
(14) Acknowledgements of written correspondence.
(15) Displays to be set up and periodically updated, regularly rotated from one location to another.

Although the information officer will manage publication and distribution, actual preparation will be undertaken by the appropriate team member responsible for technical details, or in the case of special facilities or capabilities for films and recordings, by subcontract to Alaskan business.

The costs of such an extensive effort are not inconsequential. Thus, distribution categories will be established along certain broad lines:

-- Extensive distribution, free to the public, of summary data such as information brochures and pamplets.

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-- Wide distribution of bulky or voluminious materials (such as basin plan, alternative study) to strategically located information centers (e.g., libraries). Requests for individual copies will be fulfilled at cost.

-- Pinpoint target distribution of materials for publication by others (newspaper, magazines, etc.), at no cost to the recipient.

-- Satisfaction of information requests at cost for various intermediate reports and data collections not normally routinely distributed.

We anticipate awarding one or more subcontracts (for printing and binding information materials) on a competitive basis to Alaskan firms exclusively (unless no capacity is available in Alaska at the time a subcontract is advertised).

(c) Discussion

A key element in the entire information publication process is timeliness. Thus, it will be important to ensure pertinent materials are available sufficiently far in advance of various meetings and workshops to permit review prior to the event.

Our plans to put the entire public participation program in the hands of a single manager and to deal exclusively with locally available subcontractors for logistical support of the program will contribute to our successful satisfaction of the timely distribution problem.

To maximize coverage without incurring unreasonable costs, we intend to opt for austere standards. In this regard, for example, covers (where needed) will be paper; colors will not be used except where necessary for clarity of a particular map or figure; volumes will be stapled rather than spiral bound or glued, and a variety of similar restrictions will be enforced.

(d) Level of Effort

Task Force (Acres)..........................$74,500

Total Subtask 12.04.........................$74,500

(e) Schedule

Throughout project period.

Subtask 12.05 - Prepare and Maintain Action List

(a) Objective

Provide a positive system for ensuring all issues are addressed; permit up-to-date status reports on progress and procedures for addressing issues; and ensure that all necessary actions arising from the public participation program are assigned by name to team members.

(b) Approach

Subsequent to the first public meeting, all comments will be reviewed and a list will be drawn up in the form of individual actions sought by the public. The project manager will review the list and will mark certain actions as inappropiate for further pursuit, together with a brief note explaining why the requested action was recommended for rejection.

The action list will then be completed to include, for each approved action, a control number to facilitate computer tracking, the name of the team member responsible for carrying it out, cost and schedule implications (if any), and a target date for completion. Once the list has been completed, it will be reviewed by APA, who will accept the recommendations of the project manager or revise the list as appropriate. Additional columns on action list printouts will be available to indicate status, to permit recording remarks, and to indicate the number of times the particular action has been requested by various members of the public.

The action list will be updated on a regular basis after each succeeding workshop or public meeting, or more often if significant numbers of substantive comments are received in the information office.

Because we intend to maintain the action file in an automated system, it will be possible at any time to print out information on any action whenever required; to furnish a complete action list-- including a record of actions not recommended for further pursuit; and to regularly call out the list of all actions whose status is not on schedule.

(c) Discussion

Assuming our study plan is a good one (and we are convinced that it is), it is logical to assume that most requested actions will already have been provided for.

In such cases, of course, neither cost nor schedule impacts will accrue and the remarks column of the action list will note that the necessary work is already planned. Even so, a public participation effort is specifically designed to ensure that individual concerns are considered--and it follows that some new ideas, real concerns or innovative approaches will be earmarked for consideration.

We suggest that the proposed action list system is a positive means for demonstrating to the public that their views are being carefully considered and that public participation is not being regarded as a necessary evil to which lip service must be paid.

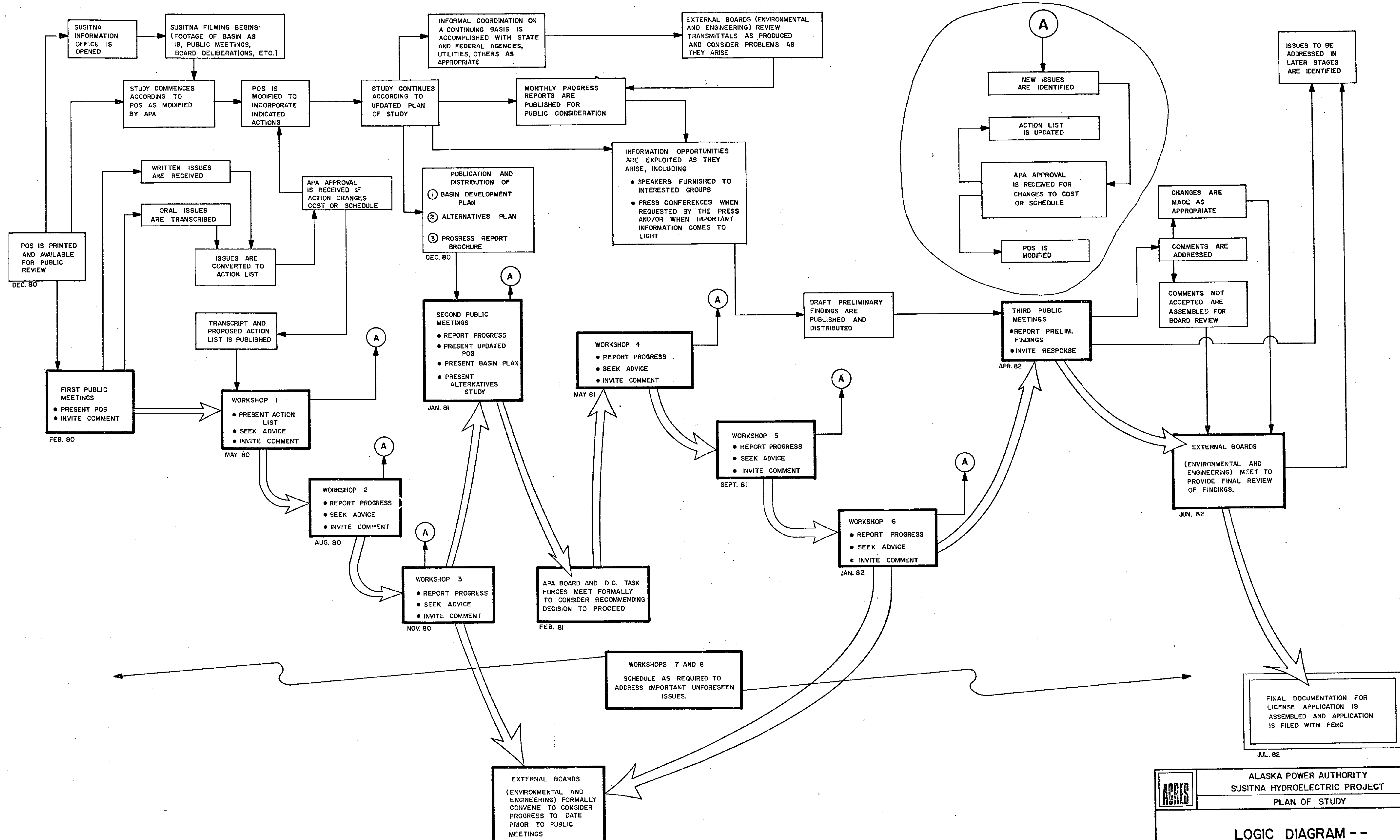
(d) Level of Effort

Task Force (Acres)............................$62,900

Total Subtask 12.05...........................$62,900

(e) Schedule

Throughout project period.



NOTES: EACH WORKSHOP SHALL INCLUDE TIMES SET ASIDE FOR FORMAL SEPARATE DISCUSSIONS WITH (1) UTILITIES, (2) INTERESTED STATE AND FEDERAL AGENCIES, (3) NATIVE VILLAGES WHOSE LANDS OR LIVELIHOOD WILL BE IMPACTED BY THE PROPOSED PROJECT, AND (4) INTERESTED ORGANIZATIONS. WORKSHOPS MAY BE OBSERVED BY THE PUBLIC.

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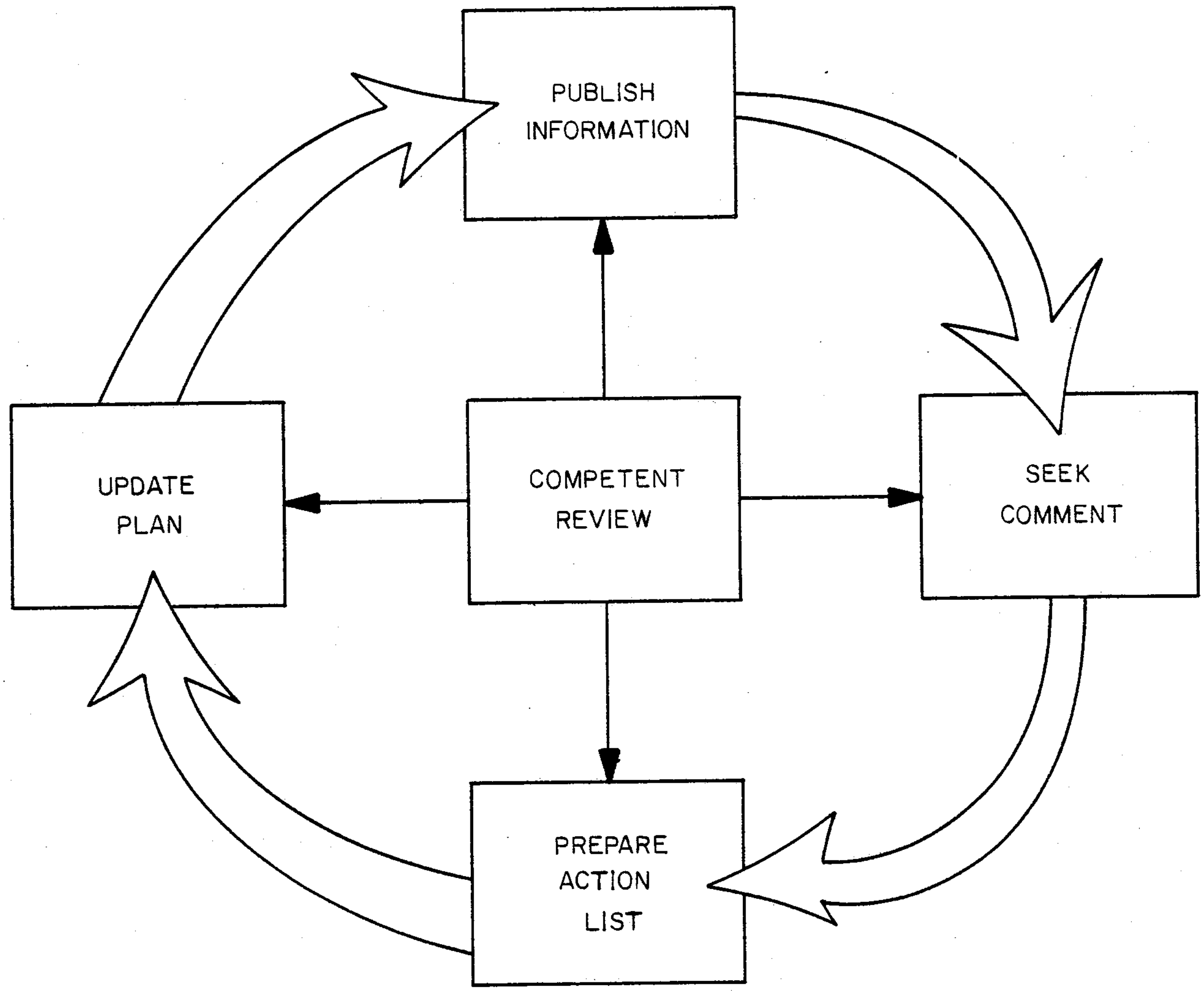
ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

LOGIC DIAGRAM -- PUBLIC PARTICIPATION PLAN

ACRES AMERICAN INCORPORATED	DATE DEPARTMENT PROJECT P 5477.00	PLATE: T12.1



ALASKA POWER AUTHORITY
SUSITNA HYDROELECTRIC PROJECT
PLAN OF STUDY

FEEDBACK PROVISIONS-- PUBLIC PARTICIPATION PLAN

ACRES AMERICAN INCORPORATED

PROJECT: P 5477.00

PLATE T12.2

TASK 13: ADMINISTRATION

A.5.14 - TASK 13: ADMINISTRATION

(i) Task Objectives

To develop for the Acres Team plans, policies and procedures that will set forth the basic scheme for accomplishing the POS.

(ii) Task Output

The following documents, reports, manuals, etc. will be produced as a result of this task:

- Division of Responsibilities Manual
- Financial Control Procedures
- Project Master Schedule
  -- Updates produced as required
- Schedule Control System
  -- Periodic reporting to management
- Cost Control Manual
  -- Periodic reporting to management
- Manpower Loading Schedule
  -- Updated as appropriate
- Accounting Policies and Procedures Manual
  -- Payroll reports
  -- Accounts payable reports
  -- Job cost reports
- Documentation Control System Manual

(iii) List of Subtasks

Corporate
13.01 - Prepare Division of Responsibility Manual
13.02 - Develop Financial Control Procedures

Project Control System
13.03 - Prepare Project Master Schedule
13.04 - Develop Schedule Control System
13.05 - Develop Cost Control System
13.06 - Prepare Manpower Loading Schedule
13.07 - Develop Accounting Policies and Procedures

Documentation
13.08 - Prepare Documentation Control System

(iv) Subtask Scope Statements

Administrative procedures will be identified and developed to form the elements of the project control system that will provide management visibility and control of the planning, data gathering, design, engineering, and, finally, license application, portions of this POS. Preparation of documentation control procedures will assure that the information so valuable to completion of the POS moves smoothly and reliably.

Subtask 13.01 - Prepare Division of Responsibilities Manual

(a) Objective

Establish the basic "How we will work" rules for the duration of the POS.

(b) Approach

Acres/Moolin corporate level personnel will prepare and review all input to this manual including:

- Project responsibility matrix
- Organization charts
- Approval authorities
- Specific duties and responsibilities of individuals/organizations
- Description of control systems and how they will be used
- Correspondence procedures

We will draw upon a depth of expertise within both organiations that has been gained on other similar projects to produce a valuable working tool.

(c) Discussion

Obviously, it is extremely important to establish early in the project, the basic documents that will be used to chart the course of the project and provide a basis for future strategy and policy decisions. The remoteness and sensitivity of the prime work location require that these policies and procedures be clearly understood by all field personnel in order that the work effort be advanced in a timely and cost effective manner.

(d) Level of Effort

Task Force (Acres)	$1,500
Task Force (FMA)	1,800
Total Subtask 13.01	$3,300

(e) Schedule

Weeks 0 through 2

Subtask 13.02 - Develop Financial Control Procedures

(a) Objective

Develop and document the procedures used to pay the project costs and to establish budgetary control procedures.

(b) Approach

Acres/Moolin will work directly with the appropriate APA personnel in order that an agreed upon plan for handling these procedures be prepared early in the project. The following subjects will be addressed:

- Funding of engineer
  - Cash advances
  - Zero balance bank accounts
- Paying project costs
  - By advances or zero balance accounts
  - Directly by APA after verification
- Budget control
  - Original estimates
  - Basis for making budget revisions
  - Budget change procedures

(c) Discussion

It is important to recognize that the difficult site conditions may well lead to severe constraints on the field data gathering operations. The possibility of expanded/revised investigative requirements that may be imposed, either by design or other outside influences (APA, Federal, environmental), should also be understood. It is important that clear procedures be in force to handle such eventualities.

(d) Level of Effort

Task Force (Acres)	$2,200
Task Force (FMA)	2,200
Total Subtask 13.02	$4,400

(e) Schedule

Weeks 0 through 4

Subtask 13.03 - Prepare/Update Project Master Schedule

(a) Objective

Establish and monitor the POS schedule showing the relative schedules of all functional areas/organizations.

(b) Approach

Each company within the Acres Team will be responsible for the identification and scheduling of all the necessary tasks/subtasks to complete the project in accordance with the overall objectives. Each of these individual schedules will then be consolidated into a tentative Project Master Schedule, the basis of which is presented in this POS as Plate A7.1 and A7.2. The schedule will be presented in two separate forms:

- Bar chart format
  - -- Showing relation to progress for each individual subtask
  - -- Indicating dates of critical milestones/decisions
- Time based logic diagram showing:
  - -- Decision milestones
  - -- Report submissions
  - -- License applications
  - -- Key meetings
  - -- Special presentations

As final reviews by APA and others dictate changes to the master schedule, it will be updated to reflect these changes. Also, the Project Master Schedule will be updated throughout the life of the project to reflect the completion of the various stages of the project and the possible changes required by early completion dates, slippages and other situations/constraints.

A computerized scheduling system will be employed for schedule control purposes. This system will be that presented in Part C3 of the POS or similar.

(c) Discussion

Adequate identification of the complete scope of work and a thorough understanding of potential constraints are the key elements to establishing a realistic schedule. For the purposes of this POS, it has been assumed that the majority of the work effort will be directed towards eventual construction of Watana and Devil Canyon dams. This seems a likely probability, however, unforeseen events may expand the scope of work at either of these two sites or even require additional work at alternate sites. Although these occurrences cannot be predicted with any accuracy and thus not scheduled, there are a number of "fall-back" positions that will be developed to ensure a timely completion of the work. Many of these problems can be handled by early identification of additional/alternate personnel and equipment, larger or alternate camp facilities, expansion of "off-season" operations, where possible, etc.

(d) Level of Effort

Task Force (Acres)	$1,700
Task Force (FMA)	1,700
Total Subtask 13.03	$3,400

(e) Schedule

Weeks 0 through 4 (Initial review)
Continuous update as required

Subtask 13.04 - Develop Schedule Control System

(a) Objective

Identify the necessary parameters, establish information gathering systems and reporting methods to eliminate or minimize schedule slippages.

(b) Approach

Acres and Moolin personnel will work jointly to accomplish the following tasks leading up to a working schedule control system:

- Each discreet activity will be entered into a weighted percent complete reporting system
- A baseline schedule for each category of work showing percent complete versus time will be prepare
- Data gathering procedures and reporting formats and levels will be identified
- Programs will be developed to:
  - -- Pinpoint and analyze all schedule slippage areas
  - -- Determine potential impact of slippages
  - -- Recommend corrective actions
  - -- Forecast anticipated completion dates
  - -- Perform regular reviews with management

(c) Discussion

Schedule control requires an accurate and timely reporting of data and the timely and committed review of data by those personnel responsible for control. The Acres/Moolin team have a great deal of experience in this regard, both in the planning of other large hydroelectric projects, and in remote, arctic environments. The ability to identify schedule problems early in the game has been demonstrated on projects of equal or greater complexity.

As in the actual schedule preparation phase, it is the constraints that must be identified, and identified early, by working directly with government agencies and others, to successfully control schedules. These agencies and others must be willing to participate, accept and commit themselves to this effort. In addition, the cost and benefits of constraints must be developed to allow senior APA and government officials to make rational go/no-go decisions.

(d) Level of Effort

	Initial	Ongoing
Task Force (Acres)	$ 2,000	$ 31,000
Task Force (FMA)	2,200	31,000
Total Subtask 13.04	$ 4,200	$ 62,000

(e) Schedule

Weeks 2 through 125

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Subtask 13.05 - Develop Cost Control System

(a) Objective

Develop the necessary management tools and control systems for monitoring, reporting and control of project costs.

(b) Approach

The cost control system will be developed using the expertise of both Acres and Moolin personnel. Proven methods used on similar projects will be employed to ensure that a workable, unencumbered system is established. The following steps will be necessary:

- Establish cost control centers. The work effort will be broken down into various elements, each of which will be controlled by a single manager/supervisor. This manager/supervisor will ultimately be responsible for all costs incurred in his area of responsibility.

- Establish a project Code of Accounts. This will be the lowest level of detail utilized by the cost and schedule control system. The Code of Accounts will allow easy identification and isolation of each basic work element.

- A cost estimate, based upon the cost estimates for each individual task/subtask, will be prepared for each cost center.

- Data gathering systems and reporting formats and levels will be established. Both manhours and dollars expended will be reported for the control period and the total to date. Completion costs will be forecasted and projected overruns/underruns will be tabulated.

- A program will be developed to:
  - -- Identify and analyze all cost overrun areas
  - -- Recommend corrective actions to eliminate or minimize cost overruns
  - -- Forecast total costs and potential scope of overruns
  - -- Regularly review with management all cost reports, analyses and recommendations

(c) Discussion

The cost center concept is a valid one and has been used successfully on other similar projects. The success of the program depends to a great extent upon the participation, acceptance and commitment of those managers/supervisors identified as having cost center responsibilities. It requires a careful selection of personnel to ensure that costs are controlled. Many qualified personnel exist within the Acres/Moolin team who are familiar with this concept.

The main center will be established at Acres head office in Buffalo where established in-house project cost-control systems have been in operation for many years. A secondary center will be established in the proposed Acres' Anchorage office and appropriately linked with the Buffalo center.

(d) Level of Effort

	Initial	Ongoing
Task Force (Acres)	$ 3,000	$ 73,000
Task Force (FMA)	3,400	73,000
Total Subtask 13.05	$ 6,400	$146,000

(e) Schedule

Weeks 0 through 125

Subtask 13.06 - Prepare Manpower Loading Schedule

(a) Objective

Establish a manpower requirements schedule for the duration of the POS.

(b) Approach

This schedule will be established to coordinate employment, support services and equipment needs. As the manpower requirements for each discrete element of work are identified, they will be consolidated, based upon the Project Master Schedule, to produce a tabulation of manpower requirements versus time and location. In addition, the equipment needs to support the level of manpower required will be tabulated in a similar manner.

(c) Discussion

The Manpower Loading Schedule is a straightforward tabulation and will be used primarily to determine the size and location of camps. However, camp size must include space not only for the engineers field personnel, but also for management, government and transient personnel.

(d) Level of Effort

Task Force (Acres)	$ 500
Task Force (FMA)	500
Total Subtask 13.06	$1,000

(e) Schedule

Weeks 3 through 4

Subtask 13.07 - Develop Accounting Policies & Procedures

(a) Objective

Develop and implement the necessary accounting policies and procedures to satisfy project requirements and support administrative control systems.

(b) Approach

Acres and Moolin personnel will work together to identify the project accounting requirements that will satisfy the needs of APA and other agencies involved, project control, procurement and tax aspects of the project. The input/output requirements will be identified and appropriate systems will be developed to provide the required output. Tentatively, all activities occurring in Alaska, both in the field and local project offices, will be processed by Acres' Anchorage office personnel with the backup assistance of the offices of Frank Moolin & Associates in Fairbanks and Acres' Buffalo facilities. Activities occurring in the corporate/design offices of Acres American will be handled by "in-house" computer capability in the Buffalo, New York offices. Written accounting procedures will be prepared and issued as soon as possible after contract award to cover the following areas:

- General accounting
- Accounts payable
- Billings
- Invoicing
- Internal control
- Auditing
- Banking
- Expense accounts

(c) Discussion

Since much of the accounting input originates from remote field locations, it will be imperative that timely and accurate transmittal of data be maintained. It will be the responsibility of the individual field supervisors and the field project manager to review all input prior to transmittal to the processing facility. It is important that the field personnel be aware of the input requirements and that they be committed to following through with this effort. Both Acres and Moolin personnel have worked under similar circumstances before and are familiar with these types of problems and how to cope with them.

(d) Level of Effort

Level of Effort	Initial	Ongoing
Task Force (Acres)	$ 9,000	$ 20,000
Task Force (FMA)	5,000	35,000
Total Subtask 13.07	$14,000	$ 55,000

(e) Schedule

Weeks 0 through 4 (Continuous update as required)

ACRES

Subtask 13.08 - Prepare Documentation Control System

(a) Objective

Establish the methods to be used throughout the project for transmittal, storage, retrieval and display of all pertinent documentation.

(b) Approach

FERC license application and APA requirements will be used as guidelines to determine the documentation requirements. In addition, the requirements of local, state and federal agencies will be included. Finally, "in-house" document flow in support of design, cost and schedule activities must be considered and accounted for. Filing systems, records retrieval and a record storage system will be established, along with orderly methods for flow/transmittal of both internal and external documentation and correspondence. Included with be a tracking system to monitor the flow of documentation between field and office locations.

(c) Discussion

Prior to preparation of FERC license application and the various individual POS reports (power alternatives, development selections, environmental, hydrological, etc), it is extremely important that a system be implemented as early as possible to control and account for the large volume of documentation that will be gathered. Particular care and attention must be used when transferring documentation from remote field locations to the central offices whre it will be reduced and stored.

(d) Level of Effort

Task Force (Acres) .... $ 500
Task Force (FMA) 1,200

Total Subtask 13.08 .... $1,700

(e) Schedule

Weeks 8 through 9

A6: POST-LICENSE APPLICATION SUBMISSION ACTIVITIES

SECTION A6 - POST-LICENSE APPLICATION SUBMISSION ACTIVITIES

A6.1 - Introduction

The study activities detailed in Sections A1 through A5 of this proposal have been provided in accordance with the APA Request for Proposals dated June 25, 1979. APA have also requested a description and preliminary cost estimate for activities which will follow submission of the license application up to a point when the license is received and construction work commences.

The Acres proposal is based on a preliminary assessment of the probable sequence of construction of project components which in turn is based on the Corps of Engineers' 1979 Report construction schedule. The first construction contract will consequently be for the Watana diversion facilities. Assuming no unforeseen, serious interventions occur during the licensing process, the FERC license (which would allow construction to commence) should be awarded by early 1985. Engineering work to that point should therefore concentrate on design activities and preparation of bid and contract documents leading to award of a diversion construction contract immediately after receipt of the FERC license. Construction of the pioneer access road to Watana should also be completed by 1985.

In this section of the proposal, summaries of activities to accomplish these objectives are presented under the same general task headings discussed in Sections A1 through A5.

No significant activity is anticipated under the following tasks:

Task 1: Power Studies
Task 8: Transmission

The following tasks will continue, but at a lower level of activity than during the first phase:

Task 2: Surveys and Site Facilities
Task 4: Seismic Studies
Task 10: Licensing
Task 12: Public Participation

The remaining tasks will continue at a similar or increased level of activity including:

Task 3: Hydrology
Task 5: Geotechnical Exploration
Task 6: Design Development
Task 7: Environmental Studies
Task 9: Cost Estimates and Schedules
Task 11: Marketing and Finance
Task 13: Administration

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The following discussion describes the anticipated activities that will be undertaken during the period through commencement of construction of the Watana project. Also provided are estimated level of effort costs for the work to be completed.

The schedule associated with this work is shown on the Summary Schedule (Plate A2.1) and on the Master Schedules (Plates A7.1 and A7.2).

A6.2 - Surveys and Site Facilities

The permanent base camp at Watana will be used as the base from which continued field studies in hydrology, geotechnical exploration, seismicity and the environmental areas will be conducted. Detailed surveying of the Watana site in support of Watana dam design activities will also be continued. The temporary camp at Devil Canyon will probably be moth-balled throughout this study phase. A description of these camps is contained in Section A.4 - Logistical Plan. A detailed list of equipment, most of which will be used in conjunction with the field activities and thus located at the base camp, is included in Section C.5.

During this phase, the airstrip at the Watana site would be upgraded to support the level of activity required to complete the preliminary engineering of the Watana facilities. At the same time, a pioneer access road would be constructed utilizing portable or prefabricated bridges.

Additional activities conducted during this phase includes photogrammetric mapping, hydrographic surveys, slope stability and erosion studies along the road access route.

Level of Effort $4,600,000

(Not including the cost of the access road or demobilization of the Watana camp.)

A.6.3 - Hydrology

Following submission of the FERC license application, work will continue on obtaining hydrologic, hydraulic, ice and climate data. This information will provide the input to further studies necessary to complete the detailed project design and prepare contract documents and specifications. The data will also be used to provide detailed information in response to queries arising out of the FERC license application and to provide partial basis for the final EIS.

A brief discussion of the additional work to be done is given below.

(a) Field Data Index and Distribution System

Work in this activity will continue as discussed under Task 3.

(b) Field Data Collection and Processing

Work in this activity will continue as discussed under Task 3. It may be possible to reduce the number of climatic stations during the later years as sufficient design information is obtained, particularly along the transmission line route.

(c) Water Resources Studies

Utilizing the 2 to 3 years of additional data obtained from the existing and the new stream gauges, the streamflow extension studies will be revised. The same methodology proposed for this activity under Task 3 will essentially be used. The streamflow data obtained from the sites will be used to improve the extrapolation of long-term streamflow data to these sites.

The "Low-Flow Frequency Duration Analysis", "Reservoir Filling and Operation Studies", and "Statistical Analysis of Pre- and Post-Project Streamflow" analyses will be reviewed and, if necessary, repeated utilizing the improved basic streamflow data and refined Watana project layouts and construction schedules. The same basic methodology as described under Task 3 activities will be employed. The "Evaporation Studies" will be updated using the additional climatic data collected.

(d) Flood Studies

The "Regional Flood Peak and Volume Frequency Analysis" will be reviewed in the light of additional data. It is not anticipated that additional analysis will be called for.

The "Probable Maximum Flood Determination" will be redone using a more comprehensive methodology than originally employed by the Corps of Engineers during Phase 1. A detailed storm maximization study will be undertaken to determine the probable maximum precipitation. More extensive meteorologic studies will be performed to improve the estimates of maximum temperature sequence and snow depths.

Consideration will be given to recalibrating the SSARR river basin model. However, should the studies in Subtask 3.05 indicate that deficiencies in the model's performance are due to inadequacies or lack of detail in the model algorithms, a more sophisticated catchment model such as the National Weather Services Flood Forecasting System (incorporating either the Stanford or Sacramento Models) or HSP (Hydrologic Simulation Package marketed by Hydrocomp Inc., California) will be substituted. These better models offer an improved representation of the infiltration process and the subsurface water balance which could be important in improving calibration results.

The "Reservoir Flood Routing" excercises will be repeated using the revised flood data and Watana project layouts.

(e) Hydraulic and Ice Studies

It is anticipated that the FERC will stipulate a significant amount of engineering to be undertaken prior to commencement of construction of the major project facilities. It may be possible to defer some of these activities until after commencement of diversion construction. However, the anticipated requirements are presented herein and included in estimated costs.

Unless substantial changes to the hydrology, the basic project layouts or system operating policies are made, it will not be necessary to rerun the backwater calculations (HEC-2) and the ice cover process model dynamic flow model downstream or upstream from the Watana site. Additional refinement of the diversion design will, however, be necessary. This will require additional runs using HEC-2 and the ice cover process model.

In addition to the above analyses, it will be necessary to undertake further computer model studies as well as hydraulic model studies. These include:

(i) Computer Model Studies

One-dimensional dynamic flow model	- Applied to Susitna reach downstream from damsite for simulating dam break conditions.
Two- or three-dimensional dynamic flow model (numeric) or alternatively an analytical solution technique.	- Applied to the proposed reservoir to simulate landslide induced surges.
One-, two- and three-dimensional water quality models	- Applied to the reservoir and downstream channel reaches to simulate water quality changes.
Reservoir sediment deposition model	- Applied to reservoir to predict location of sediment deposition (only if required and considered to be reliable).

(ii) Hydraulic Model Studies

Diversion facilities (including an ice cover)	- To refine design of diversion facilities (design for ice conditions and erosion protection)

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Spillway	- To refine design of spillway and plunge pool facilities, determine stage-discharge relationships and minimize air entrainment in plunge pools.

Glacial studies may also have to be undertaken. If significant future changes in the glacial regime are anticipated, a more intensive field program would be required to monitor these changes. If necessary, project design and/or operation would have to be modified to suit the predicted changes.

(f) Sediment Yield and River Morphology

The sediment yield and river morphology analysis undertaken under Task 3 action will be reviewed and, if necessary, modified by incorporating additional data.

(g) Access Road Studies

Additional hydraulic calculations will be undertaken to finalize the dimension of all bridges and culverts.

(h) Level of Effort $1,380,000

A6.4 - Seismicity Studies

The long-term seismic network designed under the pre-license application phase will be installed and monitored and the data assembled and processed.

Level of Effort $750,000

A.6.5 - Geotechnical Exploration

Detailed drilling and in-situ permeability testing will be conducted at the Watana site to improve delineation of the statigraphy and identify rock properties both for dam foundations and underground powerhouses. This will include borehole photography and conventional downhole permeability testing.

At the dam sites, pump tests will be conducted to determine accurately the permeability of materials in the dam foundations. A more detailed drilling program will be undertaken in the borrow areas to delineate approximately three times the borrow materials required to provide alternatives and contingencies. Sieve analysis, Atterburg limits and moisture profiles as well as hardness tests for aggregates will be performed to identify materials. Static and dynamic triaxial tests with pore pressure measurements will be run on reconstituted samples to represent in place materials in the dam. In addition, constant mean normal stress triaxial tests and resonant column tests will be performed to determine dynamic and static elastic parameters.

Drilling programs in the borrow areas will be supplemented by seismic surveys to delineate stratigraphy and provide a more complete picture.

Laboratory testing will be undertaken to evaluate dynamic soil properties under simulated earthquake loading conditions.

Level of Effort $2,500,000

A6.6 - Design Development

The objective of project design development activities following submission of the FERC license application is essentially to continue design activities to the extent necessary for project construction to commence as soon as possible after award of license. For the purposes of this POS, it has been assumed that one site, probably Watana, will be developed first. Thus activities during this period of approximately 2-1/2 years will be devoted to design of the Watana Project, and the preparation of bid documents and completion of the bidding process for the diversion system. Responses to FERC requests for additional design data prior to award of license will also be provided.

The design development concept during this period will essentially be geared to the methods of construction and the contract packaging proposed as a result of feasibility studies prior to license application. It is most likely that contracts will be packaged in accordance with construction schedule requirements over a period of some years. Thus, to minimize the financial risks, preconstruction design development costs will be appropriately spread over a period of more than 2-1/2 years, depending on the recommended phasing of award of construction and equipment supply contracts. The work that will be undertaken includes the following:

- Update of Design Criteria Manual
- Engineering support for construction of access roads
- Engineering studies, stability analyses, permafrost thaw analysis and designs for excavation, rock support, foundation treatment, grouting, drainage, embankment material sources and placement, steel and concrete structures and mechanical and electrical equipment design and selection for:

  . Dams
  . Spillways
  . Intakes
  . Penstocks
  . Surge tanks (if required)
  . Tailraces
  . Diversion facilities
  . Power facilities
  . Switchyards
  . Mechanical/electrical equipment
  . Reservoirs and site facilities

During this phase, studies for major dams and structures will include determination of design aspects such as:

- geotechnical criteria with respect to other disciplines such as hydraulic, civil and others

- design parameters from the assessment of the field and laboratory investigation data

- appropriate analytical techniques to meet the design criteria for each technical aspect of the design

(a) Dam Design

The major design effort will be on the dam and the diversion system. The main design aspects to be considered include:

- foundation and abutment conditions
- construction materials
- seismic effects
- dam sections
- cofferdams
- diversion tunnels
- permafrost studies
- construction sequence and methods

The details that will be considered for the above aspects are as follows:

(i) Foundation and Abutment Conditions

Depending on the extent of riverbed alluvium, excavation requirements will be determined for the type of cutoff (total or partial) and impervious blanket and other foundation treatments. Excavation requirements will include removal of loose alluvium and talus materials on the abutments.

Dewatering requirements during excavation will be determined using field permeability values and field pump test data and selection of primary and secondary wells.

The following studies will also be made:

- Seepage analyses for conditions during diversion and excavation of the main dam

- Seepage through bedrock foundation and abutments with consideration of permafrost zones thawed prior to impoundment and thaw due to reservoir impoundments

- Grouting requirements in the foundation bedrock and abutments and grouting methodology in cold weather including thaw analysis

ACRES

- Abutment shaping and bedrock stripping and treatment of permafrost

- Pressure relief in overburden and bedrock

(ii) Construction Materials

Further testing and evaluation of construction materials will continue with respect to impervious and rock fills, to study static and dynamic shear strength behavior and crushing potential of rock fills under high confining dam loadings. Studies related to placing constraints due to cold weather, exploitation and hauling methods along with test fills will be performed. Excess moisture contents in the impervious fills and methods of handling will be determined.

Availability and adequacy of filter and drainage materials will be confirmed. This aspect is particularly important as unusually large zone thicknesses of such material will be required for the earth/rockfill dam, as a defense against seismic effects.

(iii) Seismic Effects

The seismic design in this phase will consider in detail the following aspects:

- Review in detail the earthquake design spectrum, the preliminary design and findings from prelicensing studies.

- Evaluation of the cyclic mobility and the liquefaction potential of the foundation and embankment materials and consider in detail the various alternative methods of minimizing the damage associated with these problems.

- Evaluation of the potential for generation and dissipation of pore water pressures in the embankment and foundation materials and the possible loss of strength that may accrue as a result of these pore pressures during and following an earthquake. Dynamic analysis techniques will be used for the evaluation and prediction of field performance.

- Finite element techniques will be employed to study the dynamic response and the time history of stresses and deformations. Nonlinear material properties and the interaction between the dam and the reservoir will be given adquate consideration.

- Selection of criteria for soil placement and improvement by considering the stability and deformations during earthquake loadings.

ACRES

- Provision of an adequate system of filter and transition zones to ensure progressive erosion through continuous cracks resulting from earthquake shaking can be minimized.

- Provision of wide cores with self-healing and erosion resistant properties in the event cracking develops during an earthquake.

- Consideration of seismic effects into proper arrangement of core, transition zones, filters and shells.

Based on the evaluation of engineering conditions of the rock, design criteria will be established for rock excavation, rock reinformcement and rock support systems. Grouting requirements to treat the mass rock against seepage and uplift and the pressure relief requirements will be determined.

(b) Powerhouse Design

Rock mechanics design activities will be undertaken to prepare a semi-detailed design of the powerhouse caverns and to firm up the location and alignment based on data obtained during exploration activites.

(c) Other Design Activites

Spillway and intake structure will be founded on rock. The study will involve detailed design treatment to provide rock support and pressure relief systems to ensure stability of the structures. Rock slope stability of the spillway foundation and side slopes will be assessed in terms of the potential presence of weak zones of rock such as shear zones and joint sets, for various loading conditions with and without seismic effects.

Intake tunnel structures will involve evaluation of the structural geology, such as faults, shear zones and joint sets in order to establish the competency of the mass rock to support the gate structures. The design will involve determination of consolidation grouting, rock reinforcement, concrete lining, etc. The design of intake structures will largely be governed by geologic and hydraulic considerations.

Studies and designs of structures will be taken to the point of producing drawings to sufficient detail for bid purposes.

(d) Bid Documents for Watana Diversion System

Bid documents for the Watana diversion system will be prepared and issued on behalf of APA for bidding. These documents will include specifications and drawings adequate for bidding purposes. Bids will be evaluated and a recommendation made to APA for an award of the contract to allow construction to commence on receipt of the FERC license and other necessary permits.

Level of Effort $1,900,000

A6.7 - Environmental Studies

Subsequent to submission of the FERC license application Exhibit with studies planned and initiated prior to license application submission must be completed. The extended time period required for completion of some of the environmental subtasks is due to one or more of the following reasons:

- The required input to a specific environmental subtask must wait completion of other tasks such as surveys, hydrological studies, geotechnical exploration or design development.

- The length of life cycle that should be observed for the environmental element being studied is greater than the 30 months pre-license application period, particularly anadromous fish and big game.

- The activity to be completed is a slowly developing study that requires longer time periods in order to obtain input from all relevant groups such as archaeological digs.

- Input from FERC is desirable before the study is completed

- Some activities do not start until a license application is submitted, i.e., response to interrogatory or preparation of testimony.

As a result the environmental study team anticipates work to continue on at least the following subtasks into the post-license application phase of the overall project:

- completion of the Socioeconomic Analyses
- final registration, documentation and field invesigation of archaeological or historical resources
- completion of the land use analysis
- completion of the recreation plan development
- assessment of the finalized transmission corridor
- completion of the fish, wildlife and plant ecological baseline studies and impact analysis

Additional studies to be completed by the environmental study team in support of FERC license would include:

- construction impact analysis
- operative impact analysis
- preparation of expert testimony and response to interrogatories
- preparation of ammendments to the Corps' approved EIS for the Susitna Project
- Finally, completion and/or revision and amendment of FERC license application exhibits.

Anticipated work effort on the above listed follow-on studies is discussed in the following paragraphs. Unlike previous Tasks 3, 5, and 6, this task will still be concerned with both the Watana and Devil Canyon sites.

ACRES

(a) Land Use Analysis

During this phase the information that was generated in the pre-license application phase will be refined with the focus on the lands that have been determined to be directly impacted by the project. This refinement will aim towards the elimination of data voids, additional investigation of important leads, and the development of a more detailed description of the impacted areas. Additional interviews and field reconnaissance will be conducted.

The primary emphasis of this phase will be the prediction and evaluation of the impacts on current and future land use that would result with the development of the project. This will involve an evaluation of the future land use of the area with and without the proposed project.

The magnitude, duration, and significance of the impacts will be evaluated and discussed. The impacts will be evaluated for both the construction and operation phases of the project. A discussion of measures that could be used to mitigate the adverse effects will be provided.

(b) Recreation Plan Development

The goal of the final recreational plan development process will be to fully develop the initial recreation plan based on the perceptions of the public, the limitations of the resources, the planning guidelines of the managing agencies, and compatibility with the proposed operation of the project and other public uses of the land. It will be recalled that an initial recreation plan was described in Task 10 - Licensing.

The projections of participation at the area, and the determination of the types of facilities that should be provided, will be based on an analysis of all currently available information and data that is generated from a mail questionnaire, sent to the Anchorage and Fairbanks areas. The questionnaire will be designed to study the perceptions of the Anchorage-Fairbanks residents in terms of appropriate levels of development, and their willingness to participate at varying levels. This will provide an indication of the aggregate participation in the varying levels of development, and a means of adjusting predicted future participation.

The potentials of the resources, for providing recreation opportunities, will be evaluated to determine the suitability of the resources for use and the capabilities of the site for withstanding use. Most recreation planning decisions relate to the development of access to the area; consequently, the access road, types of facilities, and level of development are critical decisions in encouraging specific types of recreational opportunities and levels of development. Therefore, the recreational opportunities to be provided will be determined first, based on present user participation patterns and perceptions, and then adjusted to fit the limitations of the resource base.

The plans developed will be evaluated according to the following criteria:

(1) how well they meet program objectives;
(2) suitability/feasibility site studies;
(3) future management problems;
(4) estimated cost of maintenance and operations;
(5) impact of recreational use on other key values, e.g. soils stability, wildlife populations, etc,; and
(6) compatibility with the normal maintenance and operations of the hydroelectric project and other land uses.

A trade-off table will be developed showing how each of the concept plans were rated on each criterion. Adjustments will then be made and the final plan will be selected that best meets the criteria.

The final master area plan will include map(s) showing the location of the project lands and waters that will be developed for recreational uses, initially and in the future.

(c) Socio-Economic

After the initial license application submission, emphasis will be placed upon analyzing and assessing impacts at local, regional, and state levels. Regional and state levels are included because it is quite likely that there will be significant impacts at these levels. One example of this is the possible influence of low electricity rates on the growth of manufacturing and processing industries in the region surrounding the project.

Additionally, the study will focus on the effects of the project on important commercial, recreational and subsistence fish and wildlife resources. It is known that some of these resources are of substantial value to user groups and that changes in the availability of these resources could have far-ranging effects.

The design of the study will also allow for in-depth analysis and assesssment of other important impacts not yet firmly identified. This flexibility and adaptability will insure that effort is allocated only to the evaluation of relevant impacts.

(d) Cultural Resources

This effort represents the conclusion of all archaeological field investigations and laboratory analyses. Also to be included is an investigation of the cultural resources along the primary transmission line corridor. Accomplishing this task will involve the following:

(1) identification and documentation of the cultural resources, by site, of the entire study area;
(2) formulation and explication of recommendations for mitigating construction impacts on each identified site; and
(3) development of a detailed report covering not only cultural resources but also those physical parameters affecting culture.

Both state and federal regulations mandate that all cultural resources of the project area be identified and inventoried; that effects of the project on each resource site be determined; and that any impacts be mitigated before any such sites(s) are irreparably damaged. Procedures for identifying and discussing cultural resources of the primary one-half mile wide corridor will be the same as for the studies previously mentioned.

The final cultural resources report will include the location, decription and mitigation recommendations for each site reported. The report will also detail the anticipated budget for any archaeological excavation that is deemed appropriate prior to initiation of construction. The report will also include sections on culture-influencing factors such as vegetation, fauna, geology, history, prehistory and native populations. All topical discussion will be focused upon assessing the cultural resources of the entire study area.

(e) Transmission Corridor Assessment

Having established the one-half mile wide primary corridor prior to license application submission, these studies will be undertaken to further refine the corridor to a defined right-of-way no wider than that which will satisfy the minimum width requirements of the National Electric Safety Code. To accomplish this, the following will be necessary:

(1) provide environmental data to design engineers;
(2) apply previously established impact mitigation procedures to the selected right-of-way;
(3) develop the least-impact right-of-way; and
(4) recommend specific construction impact mitigation procedures.

Following the development of a preliminary right-of-way, previously established construction impact mitigation procedures will be evaluated to insure that all anticipated impacts have been properly addressed. Among the impact topics to be reviewed are: clearing and slash disposal methodologies; stream crossing and erosion control practices; and access road, structure laydown and wire-stringing zone construction methods. If unanticipated impacts are identified, mitigation procedures addressing those impacts will be developed. Restoration plans will be addressed for areas of unavoidable impact.

(f) Fish Ecology

The fisheries studies undertaken in this phase provides for continuing study of salmon to ensure that a complete cycle has been examined. In addition, studies are proposed for several areas that were not essential for license application. It is probable that new problems or areas will be identified as work continues. These will be incorporated into the program at a later date. The studies to be completed include:

- Study of the contribution of the Susitna River Population to the Cook Inlet fisheries will continue through a complete birth-to-reproduction cycle;

- Study of the distributions of adult and juvenile salmon in the lower Susitna River will continue;

- An attempt will be made to identify new spawning stocks. Because of the turbidity and the general inaccessibility of many areas, the possibility exists that there may be unknown spawning stocks. During the course of the entire program they will be sought;

- The relation of the environmental conditions to the abundance and survival of adult and juvenile salmon in the Susitna River estuarine environment will be studied. The information will be used to establish optimum water flows for the passage of the young salmon through the estuarine area;

- The relation of environmental conditions to the abundance and survival of adult and juvenile salmon in the Susitna River freshwater environment will be studied. Temperature, turbidity, food, predation stream flow and other environmental factors are important to survival and growth will be studied.

(g) Wildlife Ecology

In general, the studies undertaken after the license application submission will be more intensive, in-depth evaluation of the work that was started in the pre-license application phase.

As stated earlier for big game, it is impossible to gain the necessary understanding of habitat utilization and movement patterns within a two-year period. Therefore, the post-license application phase will form the second half of the data collection effort. It is likely that by the beginning of this phase some preliminary conclusions can be drawn; however, the pre-license application phase effort will also serve to identify areas of concern and data voids. Although some tentative impact conclusions will be drawn at the end of the latter phase, it will require considerably more data to develop an accurate assessment of the situation.

Following the identification of key furbearer species and areas of abundance and critical habitat an intensive survey of the furbearers will be conducted. A 3-year study effort started late in the pre-license application phase and continued following the submittal of the license application will be undertaken to gather data on population density, family units, home range, denning sites, diets, and seasonal use of habitats. In addition, the relationship of furbearers with other species will be evaluated. The type of information to be collected in this phase is necessary if appropriate mitigation measures are to be undertaken.

During this phase, an intensive avian census will be conducted. Small mammal trapping will be a continuation of the program started in the preceeding phase and will result in covering the minimum 4-year time period needed to identify the cyclic properties of this group.

Intensive study sites in upland and wetland habitats will provide data on bird and small mammal species composition and density in each of the most extensive habitats of the region. This will provide an indication of habitat uniqueness and productivity. Also, these intensive sites should provide data that can be extrapolated to similar habitats throughout the upper basin and should provide a basis for predicting faunal changes based on habitat changes caused by construction alternatives, including changes in water level.
If the results of the pre-license application phase identify the presence of significant concentrations of waterfowl, an intensive waterbird study will be conducted during this phase. This study will determine, for each of the major wetland habitat types of the region, the type and degrees of utilization by waterbirds, especially loons, grebes, and waterfowl.

The studies in this phase are designed to provide more than the species composition and abundance information required by the FERC regulations. Data gathered during this phase is essential to developing a comprehensive understnading of the interrelationships that exist within communities. This information will be vital in refining the impact evaluation and recommending appropriate mitigation measures. Information obtained during this phase will also be needed in order to respond to interrogatories that will be received during the license application review period.

(h) Plant Ecology

The primary objectives of this phase of the plant ecology study are to collect and analyze quantitative vegetation data for the various vegetation types to be affected by the proposed Susitna River project, and to refine impact assessments utilizing collected data.

Quantitative data will be collected from the major vegetation types present in the impoundment areas and the riparian communities downstream. This information will not only be required to describe the vegetation community, but it will also be necessary for the development and implementation of a successful wildlife mitigation program.

Low-level aerial photography (aerial quadrats) will be used to obtain quantative information on the tree species in the boreal forest. This technique is currently being utilized by the U.S. Soil Conservation Service and U.S. Forest Service in the lower Susitna River Basin.

Representative aquatic plant communities will be studied in the project area. Notes will be made on frequency, abundance, and vigor of plants. For the larger woody species, browse biomass will be calculated from canopy coverage measurements on aerial photographic imagery.

Impacts of the proposed project, especially in the downstream floodplain to Talkeetna, will be discussed in the report. Supportive literature of similar habitats and impacts on wood riparian communities will be utilized.

(i) Construction and Operation Impact Analysis

A detailed impact assessment for the construction phase and operational phase of the project will be completed. For the construction phase, impacts to be considered would include:

- Visual quality impact due to access roads, site facility, borrow pit operation, disposal of debris
- Air and Water Quality effected by land cleaning process, and construction activity within stream beds
- Primary resource utilization including fuel, materials, land and manpower
- Financial resource committment
- Safety

For the operational phase in addition to the specific impacts discussed earlier in this section and Section A.5.8 of the proposal the following will be considered:

- Visual consequence of irreversibly changing the existing boreal forest area to a reservoir area.
- Resource committment or conservation in terms of energy and land use.
- Long term Water Quality impact.
- Safety and accidental fire potential due to recreational use of area.

Most of the environmental impacts of the Susitna project will be documented in reports specifically dealing with each area, such as land use, wildlife ecology, etc. Nevertheless, the objective of this task will be to generate a report summarizing the impacts of constructing and operating the Susitna Project for each environmental element of significance.

(j) Completion of the Environmental Process

During the licensing processing, supplemental studies in all disciplines will be required for thorough impact analysis. The technical aspects of these studies will be summarized under the subtask reports for these disciplines. It is proposed that annual supplementary environmental reports be prepared for submission to the FERC during the licensing process.

Principal Investigators in each discipline will prepare annual reports on the activities, results, and conclusions of the supplementary investigations. Every effort will be made to keep these individual reports in tune with the information needs of FERC and other regulatory agencies to minimize report revisions after submission to the appropriate agency in draft form.

As necessitated by the environmental approval process or the Alaska Power Authority written testimony relating to the Susitna Project environmental report will be prepared by the appropriate experts. This testimony will be for the purpose of highlighting project organization, activities and findings in conformance with FERC license requirements. Discussions among all discipline-specific groups will be held prior to preparation of testimony. This will allow the group to deal with the most pressing issues and devote equal attention to all problem areas. Oral testimony at public hearings will also be provided as required.

Upon receipt of interrogatories, and a request by the APA to respond to such interrogatories, they will be assigned to the appropriate Environmental Study Director who will, in cooperation with the Principal Investigators, prepare an appropriate response.

Upon receipt of an interrogatory, the Environmental Study Director will make a determination as to the type of response that would be appropriate. The response alternatives are as follows:

- Alternative 1

  The data exists and can be used to prepare an adequate response to the interrogatory.

- Alternative 2

  The data needed to reply to the interrogatory exists but will be available at some time in the future in a scheduled report. If the need for a detailed response is not critical, the response will indicate when and in what form the appropriate information will be available.

- Alternative 3

  The necessary data has not yet been collected and/or analyzed. In this case, the response will indicate when a detailed reply can be prepared.

- Alternative 4

  The data needed to reply to the interrogatory does not exist and is not planned to be collected in the future. Therefore, a detailed response is impossible and will be so explained.

All responses to interrogatories will be sent to the APA for approval and submission to the party that prepared the interrogatory.

Finally any reports, addendums, or supplements required to obtain final approval of an EIS for the Susitna Project will be prepared and submitted to APA.

Level of Effort

Task Force (Acres, TES and subconsultants).........	$2,895,900
Task Force (ADF&G)	1,954,100
Total Task 7	$4,940,000

A6.8 - Cost Estimates and Schedules

Activities under this task will continue in support of the ongoing Task 6 design development effort. In particular, Engineer's estimates and schedules will be required for access road and diversion scheme construction contracts.

For purposes of effective overall project management during subsequent phases, a Program Planning Guide will also be prepared. This will provide a complete guide to identify for APA management the specific planning requirements and, for the eventual project management contractor, those products essential to the planning and management of the Susitna hydropower project.

The products of the planning guide will include the following:

- A project master schedule that shows in graphical form the major milestone dates for planning products, events and decisions.

- A consolidated construction schedule that identifies the major construction activities and shows their required start and finish dates in bar-chart format.

- Fifteen specific work packages that explain in detail the planning required for each of the following areas:

  -- Corporate
  -- Engineering
  -- Permits and land
  -- Construction support
  -- Support services
  -- Project control
  -- Labor relations

-- Contracts
-- Quality assurance and quality control
-- Camps
-- Communications
-- Procurement and logistics
-- Permanent materials
-- Construction equipment
-- Construction

Each package will explain in detail its respective area and will include:

- An explanation of the objective of the work plan
- A detailed scope of work outlining the planning products and activities to be developed within its area
- Situations and factors to be considered in developing the planning products
- An estimate of the manpower required to produce the planning products

- A detailed critical path network showing the precedence relationship and logical ties of the planning activities within the package and its logical relationship to other work packages.

- A critical path analysis that shows duration, early start date, late start date, early finish date, float and critical path for all major activities.

- An estimate of manpower required for the planning effort

- An estimate of manpower required for the pre-construction effort

Level of Effort $200,000

A6.9 - Licensing

Acres will provide all the assistance requested by APA to secure approval of the FERC license for the Susitna Project.

After the license application has been prepared and submitted to FERC, as discussed in Section A.5.11, work will continue on preparation of supplemental material to support the initial application. The principal areas of activity include all work necessary to present bid documents for the Watana Dam and completion of all environmental studies impact assessments.

At this time, an accurate estimate of the work effort to prepare testimony, respond to interrogations or attend meetings is not available. Even so, our own experience to date has demonstrated such needs will arise. The level of effort shown below includes anticipated requirements to secure legal consultation and expert testimony in response to interventions.

Level of Effort $430,000

A6.10 - Marketing and Financing

The primary shift in activity in the area of marketing and financing is the availability of Salomon Brothers as direct consultants to APA to assist APA in matters of project financing and Bond Underwriting.

Acres will continue to be the focal point of all other activities in the marketing and financing areas, particularly in the areas of risk analysis, base plan extension and revenue assurance studies. All other activities discussed in Section A.5.12 will be continued on an as needed basis to meet the needs of APA.

Level of Effort .... $ 450,000

A6.11 - Public Participation

To keep the public fully informed of the progress being made relative to preliminary design and completion of the environmental assessment, the public participation program as described in Section A5.13 will be continued into the second phase. The goal during this phase will be to continue to seek feedback from all groups, agencies or individuals identified as interested parties during the first phase. Information materials will be prepared periodically and the information office will remain active to provide a continuous point of contact for the public. However, the anticipated level of activity during this phase should be lower than prior to submission of the FERC license application.

Level of Effort .... $ 250,000

A6.12 - Administration

Project administration will continue through award of the FERC license at essentially the same level as described in Section A.5.14 for pre-license submission.

Level of Effort .... $ 200,000

A7: PROJECT SCHEDULES

SECTION A7 - PROJECT SCHEDULES

A.7.1 - Introduction

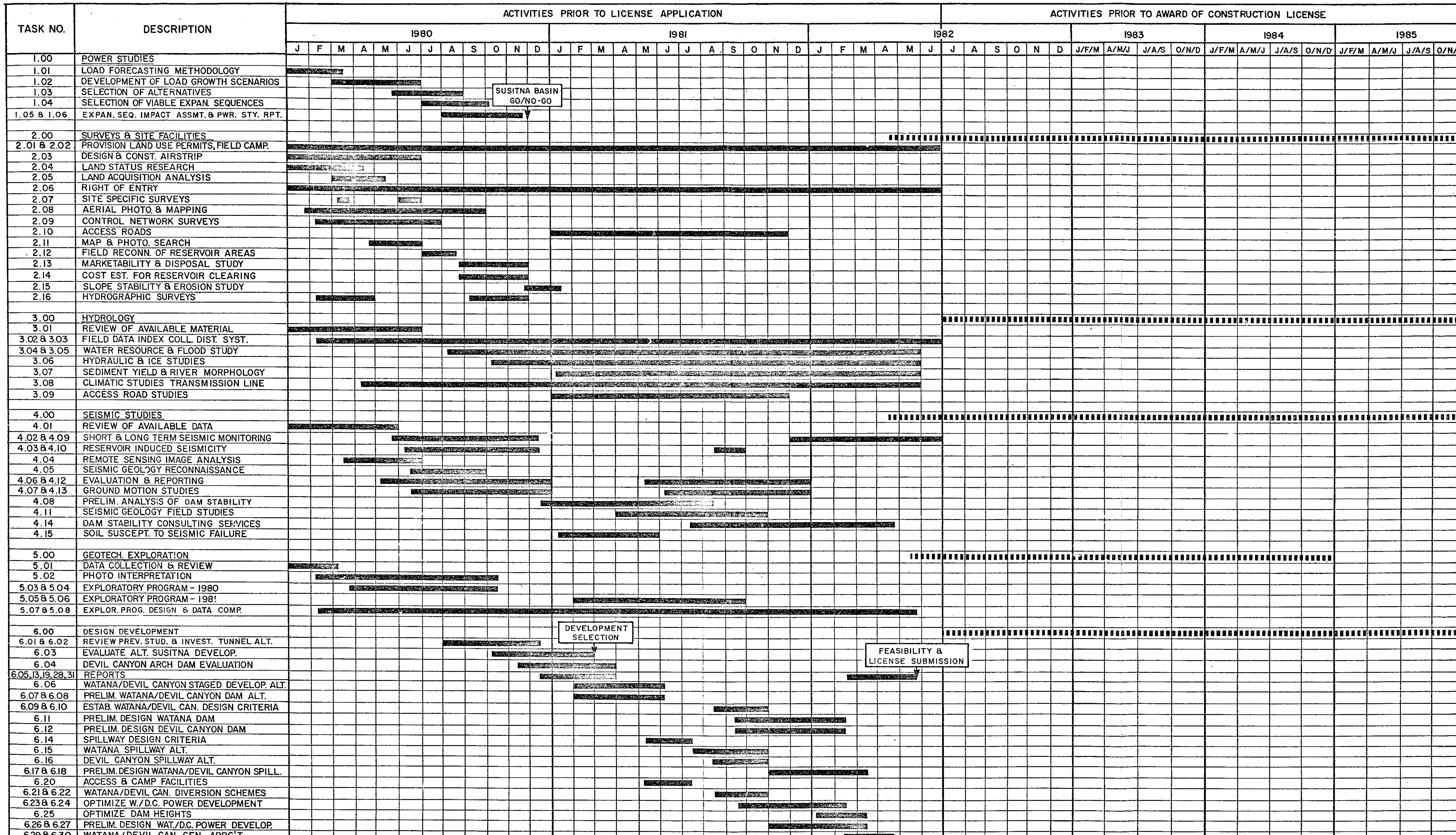
A master schedule is presented on the following pages as the basis for graphically portraying the timing of various subtasks which must be conducted concurrently or sequentially in achieving the overall project objectives. It will be noted that successful implementation of this plan demands a very early resource commitment, particularly in terms of acquiring and installing important site support facilities. By the end of the first year of work, we will have reached a decision point allowing the State of Alaska to consider recommendations to proceed as planned now or as modified as a result of our efforts to that point -- or to terminate if negative findings so indicate.

The second year of the project will include an acceleration of design activity as preliminary field investigations feed results to design teams. Design transmittals will be regularly prepared and reviewed and refinements will continue so that, during the final months of the two and one half year period, all FERC exhibits can be completed.

Reviews throughout the progress of the work will be conducted internally and externally by proposed review boards, appropriate State and Federal agencies, utilities, environmental interests, and other interested parties. During the 30th month, a review of the fully assembled proposed draft license application will be conducted so that it can be executed and filed by the State of Alaska at the end of the period.

Schedules are contained on:

Plate A7.1: Master Schedule-Sheet 1
Plate A7.2: Master Schedule-Sheet 2



SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE A7.1 : MASTER SCHEDULE - SHEET 1

ACTIVITIES PRIOR TO LICENSE APPLICATION (1980 – mid 1982) | ACTIVITIES PRIOR TO AWARD OF CONSTRUCTION LICENSE (mid 1982 – 1985)

TASK NO.	DESCRIPTION
7.0	ENVIRONMENTAL STUDIES
7.01 & 7.02	COORD. & MONITOR ENVIRON. STUDIES
7.03	EVALUATION OF ALTERNATIVES
7.04	WATER RESOURCES (QUALITY) ANALYSIS
7.05	SOCIO-ECONOMIC ANALYSIS
7.06	CULTURAL RESOURCE INVESTIGATION
7.07	LAND USE ANALYSIS
7.08	ANALYSIS OF RECREATIONAL DEVELOP.
7.09	SUSITNA TRANSMISSION CORR. ASSESS.
7.10, 11, 12	FISH, WILDLIFE, & PLANT ECOLOGY STUDY
7.14	ACCESS ROAD ENVIRON. ANALYSIS
7.15	PREPARATION OF FERC LIC. APPLIC. EXH.
8.00	TRANSMISSION
8.01	TRANSM. LINE CORRIDOR SCREENING
8.02	ELECT. SYSTEMS STUDIES
8.03	TRANSM. LINE ROUTE SELECTION 1981
8.04	TOWER, HARDWARE, & CONDUCTOR STUDIES
8.05	SUBSTATIONS
8.06	DISPATCH CENTER & COMMUNICATIONS
8.07	TRANSM. LINE COST EST.
9.0	CONST. COST EST. & SCHEDULES
9.01 & 9.02	ASSEMBLE & PREPARE DATA & COST ESTIMATE
9.03	PREPARE COST ESTIMATE UPDATE
9.04	DEVELOP ENGR./CONST. SCHEDULE
9.05	PERFORM CONTINGENCY ANALYSIS
10.0	LICENSING
10.01	IMPACT OF FERC REGULATIONS
10.02 & 10.03	ESTAB. REG. REQ. & DATA ACQUISITION
10.04	COORDINATE EXHIBIT PREPARATION
10.05	PREPARE EXHIBITS D & E*
10.06	PREPARE EXHIBIT R*
10.07	PREPARE EXHIBIT T*
10.08 - 10.00	PREPARE APPLIC. DOCUM'T. REV, EXT. REV.
11.0	MARKETING & FINANCING
11.01 & 11.02	PROJ. OVERVIEW PREP. & INT. REPORT PREP.
11.03	ALT. POWER SOURCE RISK ANALYSIS
11.04	SUSITNA BASE PLAN INITIAL RISK ANALYSIS
11.05	SUSITNA BASE PLAN EXTENSION & REV.
11.06	SUSITNA FINANCING RISK ANALYSIS
11.07	RESOLUTION OF TAX EXEMPT BOND ISSUE
11.08	IDENTIFY PARTIES IN INTEREST
11.09	REVENUE ASSURANCE PROCEDURES
11.10	LIAISON W/APA BOND UNDERWRITING MANAGER
11.11	DRAFT DOCUMENT. FOR BOND OFFERING
12.0	PUBLIC PARTICIPATION
12.01	OPERATE INFORMATION OFFICE
12.02	CONDUCT PUBLIC MEETINGS
12.03	CONDUCT WORKSHOPS
12.04	PREPARE, PUBLISH, & DISTR. INFO. MATERIAL
12.05	PREPARE & MAINTAIN ACTION LIST
13.0	ADMINISTRATION
13.01	PREPARE DIVISION RESPONS. MANUAL
13.02	DEVELOP FINANCIAL CONTROL PROCEDURES
13.03	PREPARE PROJECT MASTER SCHEDULE
13.04	DEVELOP SCHEDULE CONTROL SYSTEM
13.05	DEVELOP COST CONTROL SYSTEM
13.06	PREPARE MANPOWER LOADING SCHEDULE
13.07	DEVELOP ACC'T. POLICIES & PROCEDURES
13.08	PREPARE DOCUMENTATION CONTROL SYST.

LICENSE SUBMISSION

LICENSE

*- FOR REVISED REGULATIONS SEE ANNEX A TO TASK 10

SUSITNA HYDROELECTRIC PROJECT

PLAN OF STUDY

PLATE A7.2: MASTER SCHEDULE - SHEET 2

ACRES